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Contents.

	PAGE
Commercialism and Technical Societies	257
Graphitisation of Cast Iron	258
Correspondence	258, 263
Publications Received	258
Foundry Planning for Economical Production	259
Patent Specifications	263
The Electrical Furnace	264
The Use of Chills in Marine Engine Castings	265
Discussion on Mr. E. Longden's Paper on "An Analysis of Defective Castings"	271
Ancient Metal Workers' Blunders	272
Reaction between Manganese and Non-Sulphide	272
Iron-Cementing Compositions	273
Trade Talk	274
Personal	274
Company News	274
Iron and Steel Markets	274

Forthcoming Events.

MARCH 27.

North-East Coast Institution of Engineers and Shipbuilders:—General meeting at Middlesbrough. "Investigations of Stresses in the Rotating Parts of Steam and Internal Combustion Engines." Paper by S. Stansfield.

MARCH 28.

Midland Institute of Mining Engineers:—General meeting at Doncaster. "Notes on Devices to Prevent Overwinding." Paper by Professor J. A. S. Ritson and W. L. Grassham, B.Sc.

MARCH 31.

Sheffield Metallurgical Association:—Ordinary meeting at Sheffield. "Files and File Steels." Paper by F. M. Parkin.

APRIL 6.

Institution of British Foundrymen (Lancashire Branch):—Annual general meeting at Burnley.

APRIL 4.

Institution of British Foundrymen (West Riding of Yorkshire Branch):—Annual meeting at Bradford.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

Institute of British Foundrymen.
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Secretary: P. J. Griffiths, 20, Fisher Street, Swansea.

Foundry Trades Equipment & Supplies Association.
Secretary: K. S. Bridges, Avenue Chambers, Southampton Row, London, W.C.1.

Commercialism and Technical Societies.

With the exception of a few of the most renowned engineering, metallurgical and chemical societies, most others include in their membership a number of people who supply the industry represented with goods of some kind. The question is raised from time to time whether such membership should be permissible, and we propose to enunciate what we believe to be the basic principles underlying the situation.

Obviously such societies exist for the mutual exchange and propagation of technical knowledge with the object of enabling the profession as a whole and the members individually to advance. In order to give this last phase practical expression, some insist upon qualification for membership by examination; others allow in lieu a close examination of the applicant's professional experience. A third class of society, which emphasises the importance of the profession as a whole, rather than the individual, opens its membership to a wide range of allied professions in order to stimulate their interest with a view to a co-operative attack on problems of joint interest. It is this last class which from time to time gives the closest consideration to the question as to whether people who can be considered as having commercial interests should be admitted. The object of such societies, as enunciated, is technically to benefit all interested people, and it is doubtful whether they have the right to impute self-seeking motives to applicants, as a class or individually, and even presuming they have the right, they have not the qualifications precisely to state where a line should be drawn. Taking as an example a local society whose interests are primarily mechanical engineering. Should they accept a local jobbing foundry owner? He may desire to be a member in order to meet his customers and benefit commercially, or to obtain a better appreciation of the technical requirements of the material he is called upon to manufacture, and so aid engineering in general. We suggest that, being unable to take sworn evidence, the verdict must be given in favour of pure motives in every case.

Another phase of this unpleasant subject relates to when a qualified member makes a discovery useful to the whole of the industry, and leaves his normal professional occupation in order to develop it. Should a society excluding persons tainted with commercial interests ask such a man to resign? If they do not, they are placing him in a position more favourable than that of his non-member competitors. Surely this is another practical reason for ignoring that there can be any commercial value attaching to membership of technical societies.

It has been found, however, that certain individuals have in the past made efforts to use technical societies as a means for advancing commercial interests, and it is obviously a phase which can cause the society much harm, and, in addition, lower its status. Thus the question arises, is there no remedy for the gross breach of decency of the few other than the total elimination of the whole? We suggest strong chairmanship supported by refusal from all members to listen to any approaches savouring of business within the precincts of the meeting place.

The subject can be likened to that of commercial bribery. The man who receives an illicit commission is as bad as the man who offers it, and we suggest the man who listens to commercial talk at technical meetings is just as culpable as the discourteous salesman.

Graphitisation of Cast Iron.

At a meeting of the North-East Coast Institution of Engineers and Shipbuilders, held at Newcastle, on March 13, 1925, a lecture on "Fundamental Factors in the Manufacture and Treatment of Cast Iron" was given by Mr. J. E. Fletcher, Consultant to the British Cast Iron Research Association, whilst "The Engineer and the Development of Cast Iron" was the subject of an address by Mr. J. G. Pearce, B.Sc., Director of the same Association. The President, Mr. Tom Westgarth, was in the chair.

Mr. Fletcher, in his Paper, dealt with the fundamental factors of gases, carbon and temperature in the production of cast iron. He pointed out that the difference between actual and calculated densities of cast irons of known analysis, noted as far back as 1905, was foreshadowed as being due to gas porosity, the controlling factors in connection with which were carbon, temperature and gases influenced by the effect of time and mass. It was suggested that the blast-furnace reactions, instead of the form indicated in equations (1) and (2), as follows, were more probably gaseous in character as indicated in (3) and (4):—

(1) $Fe_2O_3 + 3C = 2Fe + 3CO$
(2) $3Fe + C = Fe_3C$
(3) $Fe_2O_3 + 3CO = 2Fe + 3CO_2$
(4) $3Fe + 2CO = Fe_3C + CO_2$

The gaseous action in the foundry cupola was also considered in detail, particularly in relation to such matters as the remelting of steel and semi-steel scrap. Referring to the suggestion by Honda and Murakami, that graphitisation was probably gaseous in character rather than due to a simple decomposition of cementite, Mr. Fletcher pointed out that the volume of gas required for the reaction proposed,

$$Fe_3C + 2CO = 3Fe + CO_2 + 2C$$

and

$$CO_2 + C = 2CO$$

is equivalent to 500 cub. ft. of CO at 1,360 deg. C. and atmospheric pressure per 100 lbs. of grey iron. The major proportion of the graphitisation must be due, therefore, to simple decomposition, although the action may be started by gaseous influence. The separation of primary, secondary and tertiary graphite at their respective temperatures was described, and finally the author dealt with the gaseous action in the malleable cast-iron annealing process.

The importance of particular temperature ranges was stressed in connection with gaseous action. At the freezing point, 1,130 deg. C., and just below, graphite formation was active, and a second less active stage occurred at 900 to 950 deg. C., and a further stage at about 700 deg. C. These temperatures were all associated with arrests or critical points in the cooling curve.

Mr. Pearce dealt with the close relationship between the ironfounder and the engineer, who is concerned both with the design of the casting itself and with its use after specifications and tests have been made. Methods which have been adopted in works of various sizes for securing close co-operation between the foundryman and the engineer were considered, and the training and functions of the foundry engineer were outlined.

The steps recently taken by the Institute of British Foundrymen and the British Cast Iron Research Association to establish in conjunction with the B.E.S.A. a national standard for cast iron were mentioned, and the other forward step taken by the industry in the establishment of organised research through the Cast Iron Research Association was considered. The main object of this Association, he explained, was to find out as much as possible about cast iron and to ensure that it was as widely used as its inherent properties and cheapness would permit. The question of sulphur influence had to be taken into consideration and problems associated with scrap to be dealt with; also the use of permanent moulds, etc. The problem was in the hands of the engineer as the consumer of cast iron. In many engineering works the engineer had the final say in all questions relating to the foundry; in other words, the manager of the works was an engineer.

Co-operation between the engineering metallurgist and the foundryman was necessary for the production of castings to desired strength, for the employment of particular tests and for the interpretation of particular results.

He thought that the principal objection which engineers had to cast iron lay in its lack of uniformity and homogeneity, rather than its low-test properties.

The author concluded by indicating the influence the engineer had upon the future cast iron development by virtue of his relationship to the founder, and by his scientific training and appreciation of the importance of experimental work.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

The Silacene Competition.

To the Editor of The Foundry Trade Journal.

Sir,—As the fortunate winner of Messrs. Thomas E. Gray & Company's "Silacene" competition I feel that, in accordance with custom, I should explain *how it was done.*

Firstly, I was attracted by the novelty of Messrs. Gray's idea, even as others have been attracted, some of them recently. Secondly, it happened on Christmas Day after I had dined—well, as one does dine on such days. Thirdly, from a dictionary, I collected some three-score jaw-breaking adjectives which I thought nobody would trouble to read. Lastly, I remembered the Co-Optimists and their restaurant act, where everything begins with "w."

Therefore, I put aside the dictionary and, using simple words only, constructed a railway journey.

To my mind, an advertisement which people read to the end is a successful advertisement, because the reader remembers it for long afterwards. I hope that everyone will read mine and, by so doing, recollect always the name "Silacene" as associated with Gray's patching. Meanwhile, I am very busy counting over the prize-money.—Yours, etc.,

Horace J. Young, F.I.C.

16, Ashfield Grove,
Whitley Bay, Northumberland.
March 19, 1925.

Publications Received.

Chemical Engineering and Chemical Catalogue. Published by Leonard Hill, 173, Fleet Street, London, E.C.4. Subscription price, 15s. per annum.

This book is a hybrid publication. It is a cross between a directory and a collection of catalogues. Apparently the object has been to present in a handy form catalogues of allied manufactures together with classified lists of makers of chemicals and chemical engineering requisites. The arrangement followed has been to set out alphabetically the various commodities, and follow on with the catalogue section. Specifications for steam-jacketted pans and filter plates and frames are included. Finally, there is an index to applications. A work of this character requires thoroughly testing before a final judgment can be given, and we look for improvements in the next edition. Some of our readers whose names should figure are not included.

New Chinese Steel Refining Plant.—Shansi authorities are organising the Yu Tsai steel refining plant in Taiyuan, Shansi provincial capital, China. Yang Chu-kou and Su Chi-jui have been appointed temporary chiefs of the plant, which is expected to open shortly.

Foundry Planning for Economical Production.*

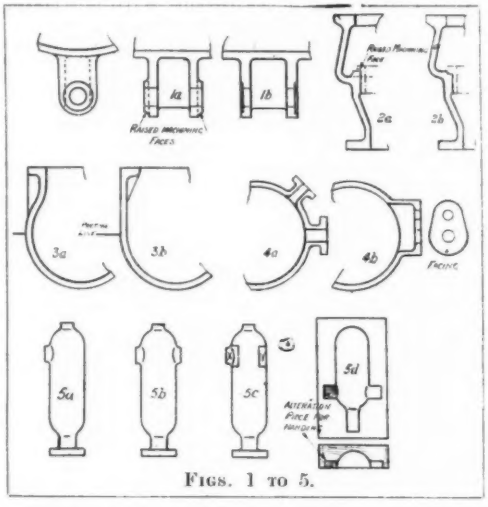
By Evan J. Ross, Holm Foundry, Cathcart, Glasgow.

Why Planning is Necessary.

In many foundries, for general engineering castings, there is a special class of work in the production of castings, for standard designs of machinery. It may not be for hundreds or thousands of castings at a time, but for an intermittent supply in batches of much smaller quantities, say, from 3 to 12, and at times, just one, as required, yet a standard product. When such castings are produced in the ordinary way, there are many operations constantly recurring, which a little foresight could obviate.

When the ordinary way of moulding is cited the constant use of loose pieces, hand-filleting of moulds, thicknessing, stamping, carding, sprigging, etc., is meant. These operations, when studied with a view to rapid and economical production, in standard work, show themselves in the light of unnecessary evils. Under this the case of the patternmaker making the pattern to suit himself without considering the foundry in any way, may be cited.

For purely repetition work, where no expense is spared in the manufacture of metal patterns and coreboxes, almost all these objectionable foundry operations can be eliminated, but for work which cannot stand the cost of such expensive gear, these operations can be considerably minimised by planning. Unfortunately, foundries are at the mercy



FIGS. 1 TO 5.

of the designing staff and patternshop, very often without redress in any way, and more so, if the foundry is not a part of a general engineering establishment.

Origin of Difficulties.

Generally, in the design of a standard product, every consideration is given to attain efficiency in the working of the machine, reduction of weight to a minimum, compatible with strength, rapid production in the machine shops and accessibility. More often than not, the draughtsman through a lack of knowledge, unintentionally embodies pattern-making and foundry troubles and difficulties.

There are very few draughtsmen who have the privilege of studying these various questions at first hand, yet they are generally quite conversant with at least the first four, that is, efficiency, strength, machining, and accessibility. This knowledge is assimilated by the drawing office staff, through being in constant contact with the personnel in the various parts of the engineering shops, or by direct study.

The designer knows from test results the efficiency of any complete machine, and is always hankering after a higher efficiency. Designs are carefully studied, particularly competitive designs, should these be available. Again, the strength of materials is well known to the draughtsman, because he has the opportunity of studying this particular subject, and has the result of years of experiment, well tabulated, always at hand. Provision is made to assist the production engineer in machining.

The inaccessibility of any part is brought to notice through the difficulties encountered when erecting. Difficulties in patternmaking and founding, little understood by draughtsmen, apart from metal difficulties, are seldom difficulties which cannot be entirely overcome in the patternshop or foundry, as far as turning out the casting is concerned. A pattern can be made to almost any design, and the moulder can devise ways and means of making the complete mould.

Patternmakers may see unnecessary difficulties due to design, which, if altered, would simplify their work, *and it invariably happens that the simpler the patterns and coreboxes are, especially for an intricate casting, the easier will it be for the foundrymen.*

Because a pattern can be made, little is heard of the difficulties in the patternshop; then, in the

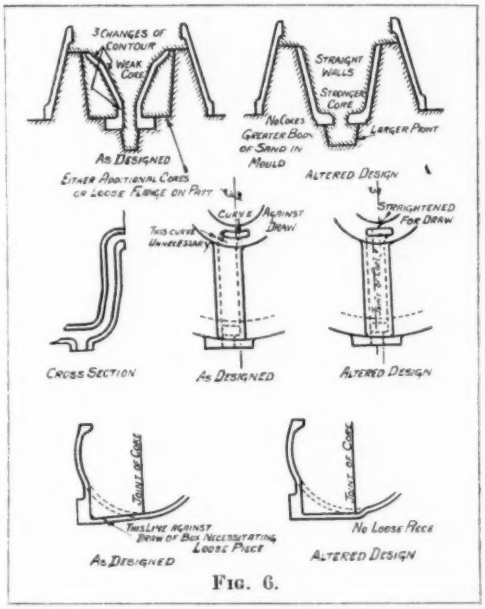


FIG. 6.

foundry, difficulties are generally taken as inevitable, and there to be overcome. *The pattern is made, and the castings are wanted quickly.*

Occasionally, draughtsmen see a casting scrapped through draw or some other defect in some particular part, which trouble might be obviated by a little alteration in design, but it is seldom that the actual cause of the trouble is pointed out, which, if done, would help to educate the draughtsmen for future designs.

Emulate Machine Shops.

Foundrymen are constantly being reminded of the progress which has been made in machine shops, under the supervision of the production engineer and his staff. Castings are now being machined at anything from *half to one-fifth* the time taken a few years ago for similar castings.

The production engineer, not only calls for castings in greater quantities within a given time, depending on the output of his machines, but for castings with a minimum of machining, and a much greater degree of regularity of contour than was previously considered necessary, or thought possible. Such circumstances make it imperative for foundrymen to try and meet the increasing demands for castings.

There are various privileges that the production engineer has been granted which might well be emulated, or taken advantage of by the foundry side of an engineering establishment. Certainly,

* A Paper read at a meeting of the Scottish Branch of the Institute of British Foundrymen, Mr. James Affleck presiding.

every encouragement has been given, and no expense spared, to attain rapid production in the machine shops. Designs have been altered to suit machining methods. Very expensive jigs and tools are designed and made. The production engineer always works on the principle, *that a jig is only made once, then why not make it perfect? The same argument holds good for patternshop work, even more so, as the value of the jig really depends on how true and how near the casting is to the detail drawing.*

Every operation in machining is carefully thought out and planned. No doubt, rapid production in the machine shops has been greatly assisted by improvements in the design of machines, and, by the use of improved materials. *One of the main reasons for machine shop progress is that the production engineer takes advantage of all improvements, in machinery and materials.* Can the foundryman say that he does so? Unfortunately, in many cases, economic conditions do not permit of installing the most up to date appliances in the foundry, but foundries can be helped considerably, with a very little additional expense in design and patternmaking. The various types of moulding machines now on the market may quite well be compared with the most up to date shop machines, as time saving devices.

Jigs are designed for machining, similarly, jigs may be designed for corebuilding and setting, ensuring accuracy in the general thickness of metal and alignment in the internal parts of intricate, or very important castings. The main principle underlying planning, for any scheme, is that all operations are predetermined, to be carried out in the simplest and surest form. If planning methods are economical in the machine shops, might not a similar effect from planning for the foundry, be hoped for more especially when the use of machines is involved. Under ordinary conditions there are many troubles and difficulties in the manufacture of a mould for a casting, and even in the casting itself, which can be seen and counteracted, prior to any time being spent on the pattern. If definite troubles can be provided for, the resulting casting will be more economically produced and nearer the ideal.

Effective Economies.

The engineer or foundryman who has realised the advantages and possibilities of moulding and coremaking machines, finds it possible to have castings produced fast enough, and with a degree of accuracy, well nigh meeting the production engineer's demands.

Undoubtedly, what strikes one as a *most extravagant use of time*, is the time taken to hand man-ram a half mould, in a box, say, 6 ft. × 6 ft. × 2 ft., when the same mould may be rammed, in a very few moments, say, on a jolt machine. Next, in withdrawing the pattern by hand or crane there is firstly, the time spent in rapping, secondly, the attaching of withdrawing gear, and thirdly, the time and exceptional care required to withdraw the pattern, with as little damage to the mould as possible. With a pattern-drawing machine the vibrating and withdrawing of the pattern is accomplished in the matter of a few moments. If the pattern is well arranged and manufactured, the possibilities of damaging a mould are very remote, thus eliminating the time spent in repairing moulds, a factor which almost invariably occurs when withdrawing a pattern by hand or crane. In this operation, the machine not only results in an economy in time, but has a much further reaching saving, in the matter of the life of a pattern. The bill to meet the damage done to patterns by hand rapping, particularly when a heavy hammer is used, is an expensive item, when converted to money, for, say, a period of a year, whereas, *wood patterns which are used on machines, will last for many years, and be as good, if not better,* than on the day on which these left the pattern-shop as new.

The use of loose pieces in moulding, with, in many cases, resulting inaccuracies, is to be much deprecated, when in many instances an alteration in design, or a simple core, saves time and gives greater satisfaction. In the matter of making cores, *it is very often much more expeditious to make a core in two, or three parts, not only for making, but for handling in the green state*, particularly if the finished core is of a very irregular contour, or has internal intricacies.

When coring an intricate mould in the ordinary foundry method it often happens that the closer has to think all the time as to how, and when, the cores must be placed in the mould. *There is no doubt that such an operation as coring a mould may be planned, ensuring that any core goes into its correct place in the correct way and in its proper order, and, once placed in the mould, need not be withdrawn.*

Foundry Planning.

The following is a short description of how a planning scheme has been successfully carried out for the speedy and economical production of castings used in general engineering, these castings varying in weight from a few lbs. up to two tons.

Some of the illustrations which are shown and described are of moulds for iron castings, made in accordance with such a scheme. The moulds, made on jolt, roll-over, pattern-drawing machines, and the cores—of silica sand—turned out on to flat plates, whenever possible, either by hand or by machine when too large or too heavy to be manœuvred by hand.

Planning Procedure.

When a detail of any standard piece of machinery—in the form of a casting—is designed, a copy is immediately issued to the foundry planning department, for the consideration and elimination of the patternmaking and foundry difficulties which may be incorporated. The procedure under such circumstances is as follows:—(1) Consideration of the various ways of making the mould, and in conjunction with this, how the casting will be cast. (2) Consideration of the most suitable type of mould, whether green sand, dry sand, or silica sand. When considering the type of mould it must always be remembered that if a dry-sand mould is used, there is firstly the expense of drying, and secondly, the loss of the use of the box while in the drying stove. This is a very serious matter when on production. (3) Consideration of where and how the pattern will be parted if a split pattern is necessary. When these three points have been discussed and settled, a plan, and if necessary, sections, of the mould are drawn out. This drawing, generally designated a "Method of Moulding" drawing, permits one readily to visualise the various patternmaking and foundry difficulties in the design. (4) Difficulties encountered due to design in relation to the withdrawing of the pattern from the mould; also intricacies in the corebox manufacture and core making. (5) Probable difficulties due to design, such as draw, contraction, etc. (6) Ensure proper venting, and (7) gear required.

If any alterations to reduce patternmaking costs or facilitate moulding are considered necessary, these are marked on the detail drawing or shown on a special drawing, and returned to the designing office, where, if possible, these alterations are incorporated in the final design.

When the final design is issued a complete "Method of Moulding" drawing is made embodying the following:—(1) Patterns required. (2) Size and shape of all core prints. (3) Joints of cores indicated, where a complete core is made in parts. (4) Arrange for the minimum number of coreboxes most suitable for the expeditious production and handling in the foundry. (5) Any exceptionally difficult core-box is detailed and the arrangement of any interchangeable, loose or removable pieces clearly defined. (6) Core-locking and registration devices are arranged. (7) Ensure that all cores are rigidly held in position, and if chaplets are necessary, the number and position of same are fixed. *Every chaplet in a mould, especially a stud chaplet, is a plentiful source of danger to the production of a perfect casting, therefore too much stress cannot be laid on the fact that these must be eliminated wherever possible, particularly in moulds for important castings;* and (8) decide on how mould will be cored, carefully watching core clearances.

With large cores, when special core irons are considered desirable, these are designed and made of steel in place of the usual cast-iron grids. This type of core iron does not get broken as the cast

iron does when the cores are being knocked out. Provision is made in the core-box for carrying such core irons, making their insertion the simple and expeditious operation of laying the iron in the registration pockets and on the supports. Provision is also made for handling large cores.

To explain more fully the various points of the foregoing procedure a few illustrations are necessary.

Ways of Making Mould.

In many instances this is governed by the shape of the casting, and in others by the duty which the casting will be called upon to perform. The mould may be made for coring and closing horizontally, and arranged for either horizontal or vertical pouring; or again, it may be made for coring when in a vertical position. This, together with "type of mould" and "parting of pattern," will be more fully discoursed upon when illustrations of moulds are detailed.

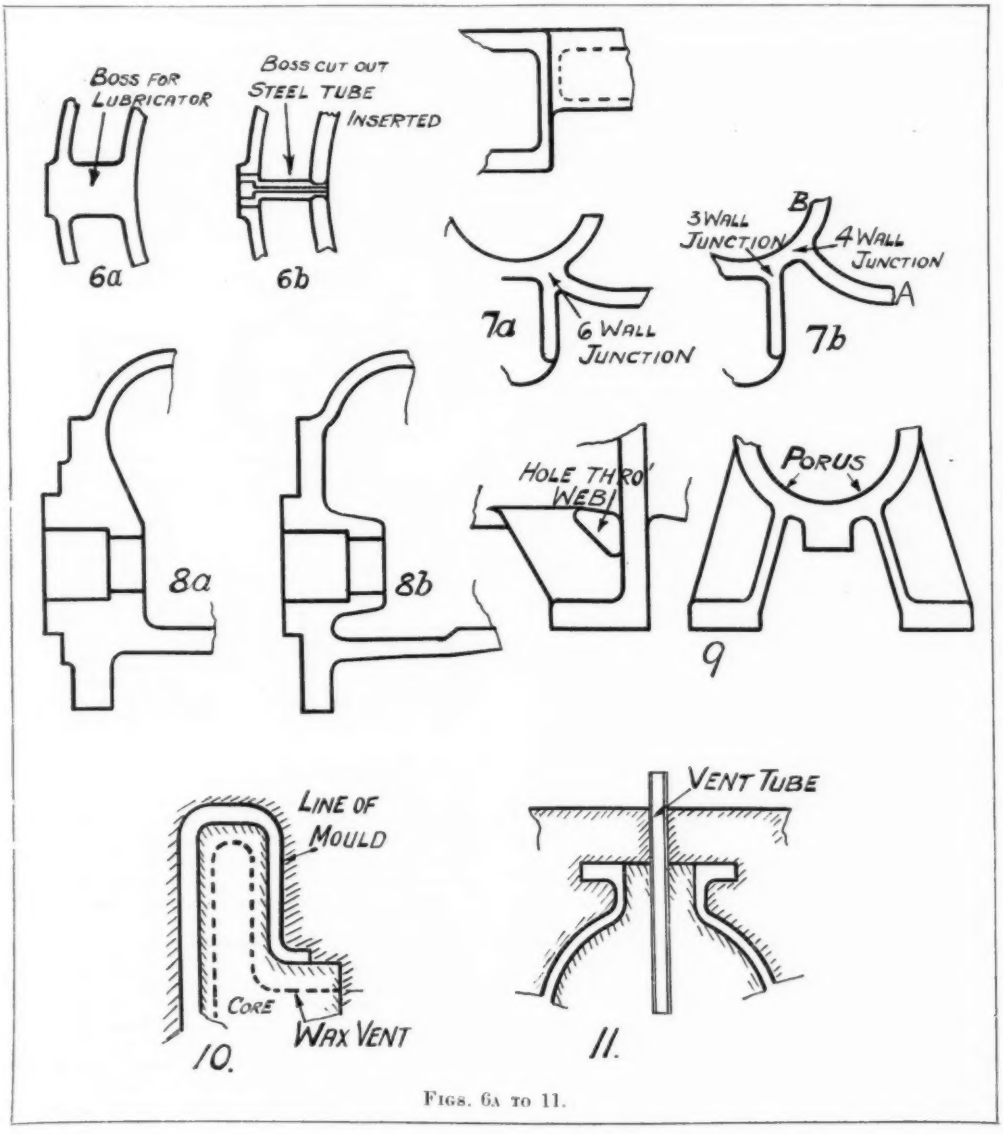
Another phase, "Troubles encountered with regard to draw of Pattern from Mould and intricacies in Core-making," calls for the following remarks:—

Fig. 1 *et seq* show a few cases—which are fairly general—of difficulties in moulding and core-making, due to the design, and how these difficulties may be overcome without disturbing the general design of any casting.

Fig. 1a shows a support having machining faces which necessitate either loose pieces with their oft-times irregular effects or cores, but may be made flush, as 1b, which gives an easy draw with a better-looking finish. These faces are then machined by a spot facing.

Fig. 2a is of a similar trouble inside a valve chest. This also entails the use of a loose piece, sometimes a very delicate piece, especially in a thin section low-pressure Routledge valve, or an extra core, either of which can be obviated by having the chest designed as at 2b. This is a serious difficulty in globe or straight-through valves.

Fig. 3b shows how a rather difficult piece of foundry work, 2a, is overcome by altering design. The flat wall, 3b, is brought straight up to the outside of the flange, the inside of the flange being taken out with the main core. *This is a particular case where the duty which the casting is called upon to perform must be taken into account, as the section* 3b *is not by any means as strong as* 3a.



FIGS. 6A TO 11.

Fig. 4a is a very common arrangement of branches on any cylindrical casting, and the moulding and coring of the angled branch are operations which take a considerable time. Such branches are very often only for pipe connections. By pointing out the difficulties both in moulding and coring an alteration as shown at 4b in all probability may be arranged. Whilst this is rather an extreme case, the advantages gained in the foundry by this alteration are very obvious, and it is also of great benefit to the machine shops, as there is only one setting required when machining the faces.

Fig. 5a shows an air vessel having a boss for an air cock. No matter what finish is called for on

a job, an extra boss, as shown at 5b, will not spoil the look of the job nor waste an excessive amount of material, yet it cuts out the making of a half-pattern, *i.e.*, when the pattern is mounted on a plate, also eliminating the necessity of changing the half-patterns when moulding. It is also a most suitable way of making provision for jobs which are handled.

Fig. 5c is an alternative arrangement requiring only one half-pattern and yet having only one boss on the casting. The interchangeable pieces x and y are changed over when one half of the mould is made, which change only necessitates the manipulation of a few screw nails. *This method can be adopted on innumerable occasions for branches, brackets, facings, etc., on patterns or in core-boxes, as* Fig. 5d.

These simple illustrations show various points which are very often overlooked and might with advantage be embedded in the design of fairly large castings.

Alterations to simplify moulding and core-making are also a benefit in pattern making, as each one decidedly reduces the cost of pattern making.

Fig. 6 shows various alterations which have been carried out in one casting to reduce pattern-making costs and simplify moulding. Freehand sketches similar to the "altered designs" were submitted to designer and incorporated in the final design. The first alteration reduces pattern-making costs by having a straight wall in place of three changes of contour, and also cuts out the additional cores, which meant core-boxes and cores to make or working with a loose flange in the foundry. The benefit of a much stronger mould and core is also obtained.

The second alteration cuts out a curve in a very slender drain core. The core is illustrated by cross section and "as designed" entailed the manufacture and working with an awkward core-box. The altered design is a much more straightforward job; also the core is stronger when the possibilities of bending are considered, due to weakening of core by heat from metal. The third alteration to an oil box drain sump is self-explanatory. When the advantages gained by such alterations in design are once pointed out to the drawing office staff they quite naturally carry them out in all work, and it becomes a matter of course, yet has very far-reaching effects, even in jobs which are not standard.

Fig. 6a shows two cylindrical walls of metal with a boss for a lubricator between. This boss, very thick in comparison with the adjoining walls, would in all probability have shown a considerable draw when drilled, necessitating bushing with steel. Fig. 6b shows the boss cut out and a steel tube inserted. In the manufacture of the core-box this boss is certainly an additional expense, and again, if inclined from the vertical, *i.e.*, as the box draws from the core, it is a very awkward part in the core making. Overcoming these latter two difficulties in themselves quite warrant the alternative method being employed.

Fig. 7a is an example of six walls of metal meeting at one point, and this is undoubtedly a fairly certain source of draw. It is not only the joining of the walls of metal, but it is the formation of an *aggravated T section*. To reduce the volume of metal at the junction the vertical walls were separated, as shown at Fig. 7b, where wall A is made to join wall B radially.

Quite a common form of junction of walls of metal is shown at Fig. 8a, also an abnormally thick portion. With the casting designed as at Fig. 8b these sources of draw are perhaps not entirely overcome, but the chances of draw are greatly reduced. Where the circular wall meets the vertical wall tangentially (Fig. 8a) there is an excessive thickness, which is cut out by the alteration as in Fig. 8b. The under side is also reduced in metal.

Another method of preventing draw not very often resorted to, particularly in cast iron, is in taking the corner out of a web, as shown in Fig. 9. This is seldom if ever shown on a detail drawing, and if used in the correct way does not weaken the web. Castings when machined prior to having this corner taken out showed a considerable draw and were rejected at test. This is often carried out even before a trial casting has been made.

One reason for abnormal changes of section in castings is that the draughtsman quite overlooks the additional metal required for machining. To take the example of a cylinder barrel, say finished at 1 in. thick, having ports and attachments, such as supporting brackets, the connecting walls will generally be found to be about $\frac{3}{8}$ in. thick. The variation in metal thickness does not look exceptional as drawn, until $\frac{1}{4}$ in. machining is added, when the difference in metal thickness is increased to 100 per cent., *i.e.*, $\frac{3}{8}$ in. metal forming a T section with $1\frac{1}{4}$ in. metal.

These illustrations are given to show the type of trouble which is generally embodied in designs and to which the draughtsman gives either little or no thought. *When it is desirable to alter a design it is imperative that an alternative be submitted.* In doing so a lead is given, and once given, it will often be found that the designer can improve upon it.

Venting.

The precautions necessary for easy venting are not so numerous when cores are made of silica sand in place of ordinary sand. Due to its free venting qualities, it is very seldom that an additional core vent hole is found necessary. Wax vents are practically eliminated, and are only used to ensure that a vent reverses, Fig. 10, or, in the case of a very fine core, that the vent may be kept open where the section of sand is very small and irregular and the quality must be varied a little and strengthened by additional bond.

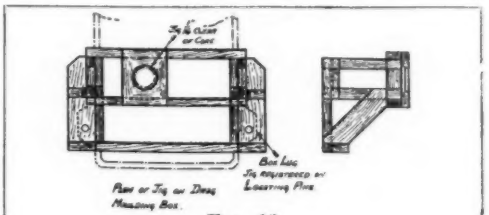


FIG. 12.

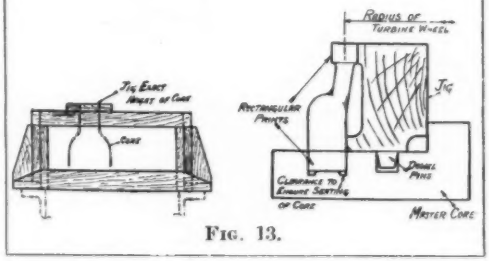


FIG. 13.

By cutting channels in the centres of the cores before pasting the halves together, a very free vent is obtained. It is often found advantageous to insert a tube into a core centre, as Fig. 11, giving an easy exit for the gas from a large volume of core sand, thereby reducing the chances of a blown casting.

Gear Required.

On completion of the Method of Moulding Drawing there is tabulated the following:—Patterns necessary, whether one-half pattern or cope and drag patterns. When two half patterns are necessary respective halves are marked cope or drag. In some cases this is done with raised letters imprinting same in mould, so that no mistake will be made when closing. When only one-half pattern is used this is typed "cope" and "drag," thus preventing the chance of only making a half casting.

All core-boxes are scheduled and given an identification letter, which is imprinted on the core by a raised letter in the box. For a complete box the letter is, say, A, but if the core is made up of various parts, each part has the addition of a numeral, such as A1, A2, and so on.

A copy of the planning drawing is now forwarded to the pattern shop, and is used in conjunction with the detail drawing. This ensures that the manufacture of the patterns and core-boxes is most expeditiously carried out, as the patternmaker has only to think on the actual construction of patterns and core-boxes.

Should a jig for core-building or alignment of a core in the mould be considered necessary this is

also arranged and detailed. Such jigs, made of wood, are constructed by the patternmaker from a jig detail drawing. Figs. 12 and 13 will show exactly the types of jigs referred to. Fig. 12 illustrates an arrangement of jig for the alignment of a core before putting cope mould in position. The thinner the metal of a casting, the more serious are the effects of the slightest inclination of a core from the vertical. Such a type of jig may be practically a false cope mould, registered truly by the locating pins and governing the exact position of various cores. This jig cuts out the necessity of trying green sand copes for even thicknesses. Fig. 13 is an illustration of a jig for positioning the cores of a turbine nozzle segment. The jig is registered in the master core by dowel pins, and the nozzle cores are positioned, truly vertically and radially, also the correct height is assured.

On delivery of patterns, core-boxes, and any special gear required at the foundry, there is forwarded to the superintendent all information necessary for organising the production, which includes:—(1) The pattern plate on which the pattern is to be mounted. (2) The moulding box most suitable for the mould, and for which the pattern plate is arranged. (3) The number of cores, or parts of cores, required for one casting. When a core is made in parts, information is given on the parts which require pasting together, each part being easily picked out by the identification letter and numeral. If it is necessary to file a fillet on any core this information is also given, so that the core is finished and ready for the mould on leaving the core room, and (4) the order in which the mould must be cored. This includes the hanging of cores in the cope, a practice which is avoided if at all possible.

If any casting has to withstand an exceptionally severe test pressure, say, from 500 to 2,000 lbs. per sq. in., this information is also forwarded to the foundry superintendent.

(To be continued.)

Patent Specifications.

Particulars of patent applications accepted furnished by Mr. Eric Potter, of Lonsdale Chambers, 27, Chancery Lane, London, W.C.2, and Commerce Chambers, Parliament Street, Nottingham, and from whom further particulars may be obtained.

Sperling, M. Process for the melting of metals for the coating of metal articles with protecting metals and for soldering.

Faconeisen Walzerkl, Mann Staedt Et Cie Akt Ges and Banben, H. Hearth smelting or heating furnaces. No. 228,599.

Electro Metallurgical Company. Processes of making rustless iron and similar alloys. No. 206,836.

Duqueene, C. Suspended roof of refractory material for furnaces. No. 214,970.

Marks, E. C. R. Alloys or compositions for treating molten metals. No. 228,757.

Mossay, P. A. H., and Ransomes, Sims & Jefferies, Limited. Charging apparatus for use with annealing ovens, furnaces, and the like. No. 229,007.

Krupp Akt. Ges. Friedrich-Alfred Hutte F. Devices for manufacturing steel. No. 220,279.

Imrie H. Swanson Inc. J. E. Processes of casting hollow metallic cutting dies. No. 229,176.

Peters & Company, Limited, D. G., and Hibberd, F. C. Metal rolling mills or like machines. No. 229,401.

227,270. Refractory Substances.—Morgan Crucible Company, Limited, and Lindsay, P., Battersea Works, Church Road, Battersea, London. December 17, 1923. No. 31,656. [Class 22.]

Refractory substances containing clay, graphite, aluminium silicates, etc.—Crucibles, etc., are made from a mixture of clay, graphite, and a compound of alumina and silica having the composition $Al_2O_3SiO_2$, such as sillimanite sand, silicon carbide, etc., also may be added. Several examples are given in the specification, of which the following is typical, 30 per cent. of crystalline graphite, 20 per cent. of clay, 10 per cent. of sand, 10 per cent. of silicon carbide, and 30 per cent. of $Al_2O_3SiO_2$.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Refractory Materials.

To the Editor of The Foundry Trade Journal.

Sir,—We have read with interest in your issue of February 19 Mr. V. C. Faulkner's Paper, "Some Notes on Refractory Materials," read before the Institute of Metals recently. The process at Templetown Brickworks has been specially laid out and arranged to produce, under strict scientific control, a brick embodying certain recommendations emphasised by the author as extremely desirable. The remarks in the Paper to which we would specially refer are:—(1) The laboratory should indicate the amount to be allowed for expansion; (2) dimensionally correct bricks and the question of grinding to size and shape; and (3) burning to sufficiently high temperatures in the kiln.

Concerning point (1), a large laboratory equipped with all the necessary furnaces, instruments, etc., is regularly engaged on research work and routine tests, and it is always willing to supply interested persons all available information which would be of assistance to them when building in and using the brick.

The questions raised by point (2) were specially considered when laying down the plant and process. We are of opinion that silica brick can be manufactured sufficiently accurately as regards size and shape without the necessity for grinding,

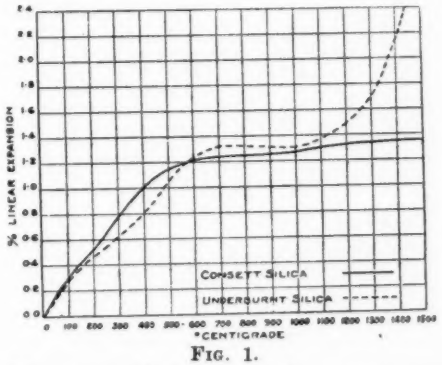


Fig. 1.

and have despatched to you, under separate cover, suitable samples of our products for your inspection. These are not picked samples in any sense, but just the ordinary run of manufacture, about which we guarantee size to within 1 per cent. of drawing dimensions and absence of twisting, warping, etc.

Point (3), the burning of the brick, also receives special attention, this process being normally carried to much higher temperatures than those usually attained by most manufacturers, which results in a brick of extraordinary mechanical strength and freedom from after or permanent expansion.

The curve (Fig. 1) is typical of a large number of routine expansion tests, and from which it will be noted there is no increase in expansion after the thermal expansion is complete. As a matter of fact, our ordinary kiln treatment carries the conversion of the quartz so far that on heating the brick to 1,600 deg. C. a small shrinkage is recorded due to the transformation to cristobalite, the form with the smaller volume.

In connection with the above remarks generally we may mention that we built about 4,000 tons of "Consett" silica material into our Fell Coke Works, which plant is now carbonising over 7,000 tons of coal per week. The accuracy of size and shape was such that not a single brick had to be cut. On heating up the expansion was most regular, and proved to be exactly the amount anticipated. We have had similar reports from elsewhere.—Yours, etc.,

A. H. Middleton.

The Consett Iron Company, Limited.
March 13, 1925.

The Electric Furnace.

By H. Burton Smith.

The method of making steel in the electric furnace is somewhat more or less in its infancy, though great strides have been made since 1914. The advantage of this furnace compared with the open-hearth and Bessemer types is that the metal is easier to "kill" on account of the reducing atmosphere which is present. The atmosphere of any furnace influences the slag to a great extent, and the slag in its turn governs the metal. During the working-down period the metal in an electric furnace is affected in a similar way to the metal in other types. The silicon and manganese which are present in the metal charged being reduced first.

In Table I are tabulated the analyses of samples taken during the working-down period of an electric and Siemen's open-hearth furnaces.

The Snyder furnace is circular in shape, tapering at the bottom, and having two side doors which work on hinges. These two doors are used for charging purposes and when a heat is in progress they are well fastened and luted over. A sliding door is placed in front of the furnaceman which can be opened and shut as desired, exactly the same as an open-hearth furnace door, but much smaller. When a heat is ready for tapping, a slag brick made of good moulding sand and shaped so as to fit in between the sides of the front door is used to hold back the slag. The furnace is fitted on rockers and electrically tilted.

The lining of the acid furnace is as follows:—A 2-in. layer of kieselguhr is placed round the inner side of the shell except where the side doors are. Next is a similar layer of ground firebrick, pea-shape in size. Below the doors the walls are lined with 9-in. and 4½-in. tarred silica bricks, making the thickness from the shell to the surface lining 17½ in. Above the slag line composite bricks, circular in shape, take the place of silica bricks, the same thickness of lining being used. These bricks are compounded from ganister rock and fine ganister mixed with tar, the tar acting as a binder. In lining the furnace no two joints are placed opposite one another; thus if the jointing between one brick gave way the metal would not come into contact with the jointing of the brick behind.

For the roof tarred silica bricks are used, these being held together by a circular steel plate. The roof is not attached to the furnace itself; a layer of sea sand and carbon is placed on the top of the walls of the lining, so preventing the roof from fusing to the walls, hence a new roof can be replaced in a very short time. The silica bricks used for lining purposes are all saturated with tar. The function of the tar is the tendency to increase the refractory properties of the bricks, and to act as a binder to the cement. This action is due to the carbon left behind when all the volatiles of the tar have been driven off, carbon being a highly refractory substance.

Great care is required when ramming the bottom of a single-phase furnace, or trouble will be caused by the bottom boiling up towards the end of a heat. This is one of the chief drawbacks to this type of furnace. When the charge is all molten it is noticed that some magnetic phenomenon takes place, the metal gradually being revolved round in clock-wise direction the whole time. This helps to keep the bath homogeneous. The working of the furnace is similar to that of the open-hearth, the slag is easier to control, and better finishing slags are obtained, which means that the metal is in a higher state of deoxidisation. The analyses of the two typical slags given in Table II show the difference between electric and open-hearth slag. In the case of the electric slag lime had been added, the slag having a very fine chocolate-coloured glazed surface.

Table II.

Acid Electric-Furnace Slag.		*Acid Open-Hearth Slag.*	
SiO_2	64.00	SiO_2	50.24
FeO	12.36	FeO	23.91
Al_2O_3	7.20	Al_2O_3	1.30
MnO	10.23	MnO	21.67
MgO	Trace	MgO	Trace
CaO	5.90	CaO	2.80

The basic process for the Snyder furnace was found to be unpractical, though several heats have been worked with very good results, the sulphur and phosphorus being below 0.020 per cent., and especially in the case of the former, for this was always reduced well below 0.020 per cent. The difficulty was found in the arc, too much heat radiating to the furnace roof and walls causing them to flux badly. In a furnace after the style of the Héroult, where three arcs are in operation, the radiation is not so great, as smaller arcs are used. The slags produced by the basic method were excellent from the deoxidisation point of view, but were infinitely more difficult to control. The metal was slagged after the dephosphorisation period, then a new slag composed of eight parts of lime, one of silica, half of carbon and one of fluorspar was added. It was found that the relationship between the calcium oxide and silica played a very important part. The limey slag would combine with the silica as calcium silicate up to a certain point; beyond that limit the excess silica was reduced, and taken back into the metal as silicon, thus causing high silicons and rendering the metal unsuitable for rolling purposes.

Table I.—*Analysis of Samples taken during Working-down Period in Electric and Open-hearth Furnaces.*

	2-Ton Acid Snyder Electric Furnace.					*15-Ton Acid Siemens Open-Hearth Furnace.*				
	1.	2.	3.	4.	Cast.	1	2	3	4	Cast.
C	0.30	0.29	0.30	0.27	0.30	1.81	1.50	0.89	0.73	0.45
Si	0.047	0.016	0.016	0.014	0.27	0.80	0.06	0.05	0.02	0.093
Mn	0.07	0.06	0.09	0.07	0.62	0.31	0.03	0.02	0.02	0.76

Average Metal charged.					*Average Metal charged.*				
C	Si	S	P	Mn	C	Si	S	P	Mn
0.45	0.30	0.050	0.048	0.80	2.5	1.4	0.033	0.035	

Comparing the physical properties of steel, there is still some controversy as to whether electric steel is superior to that made in the open-hearth. Here a great deal depends upon the practical working conditions. The author's opinion is that the former is the superior metal. With the bottom-electrode furnace it has been found impossible to free the metal entirely from slag. Experiments have long since shown that slag inclusions can exist in two distinct conditions. In one the slag is inter-granular, and takes the form of a series of chain-like nuclei of ferritic bands. This is the type of structure which is associated with the worst physical properties. On the other hand the inclusions are of a globular and disconnected structure, each inclusion being enclosed and isolated by a separate ferrite grain. In this case no continuous bands of slag spoil the existing ferrite, and the resultant physical properties are good. This suggests that the deficient ductility is not so much a direct result of the presence of slag in the metal, but of the concentration in, and consequent weakening of, the continuous ferrous bands. Experiments proved that the former type of structure was due to bad annealing, although it is capable of complete modification through annealing. The presence of slag operates directly or indirectly to diminish the susceptibility of the steel to such heat treatment, consequently rendering a lengthy annealing necessary.

[The magnetic phenomenon exhibited in molten steel is most interesting, as it is generally understood that steel loses its magnetic properties at the AcI point. We entirely disagree with the author if he extends his statement as to slag inclusions to include all conductive hearth furnaces.—Editor.]

The Use of Chills in Marine Engine Castings.*

By J. W. Frier (North Eastern Marine Engineering Company's Works, Limited).

Of the problems confronting the engineer and the foundryman at the present day the manufacture of sound cylinders and cylindrical castings is possibly the most pressing.

Faulty cylinders are responsible for the heaviest losses in both the foundry and the machine shop, and many foundries have been financially embarrassed in attempting manufacture at the present time. The number capable of producing sound cylindrical castings is very limited.

Since starting to write this Paper, the author has endeavoured to find some information and opinions in the printed Proceedings of the Institute, but has only been able to find two Papers dealing with chills or denseners. The late Mr. E. H. Broughall, M.I.M.E., in a Paper given at Birmingham, said: "It is to be regretted that foundrymen have given this most important subject such scant attention, the majority satisfying themselves by using denseners on the most simple castings. It is a subject which has huge possibilities and opens up a way whereby far better products from the foundry can be obtained."

Further on, he says, "As regards the use of ordinary denseners, it is, of course, understood that the necessity for denseners is caused through the uneven rate of cooling of thick and thin

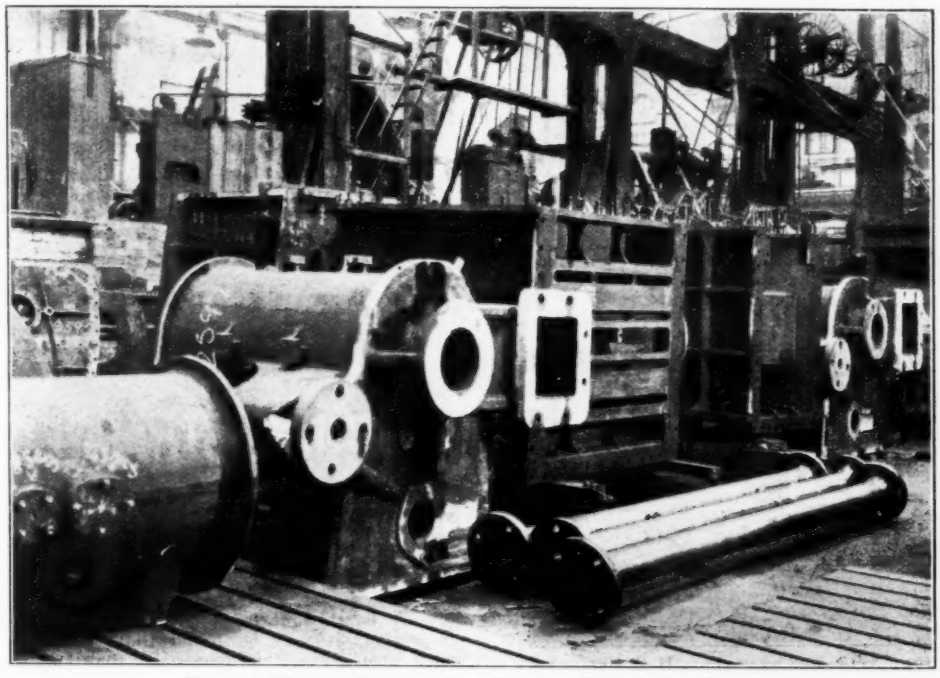


Fig. 1.—Marine Cylinders at Various Stages of Machining.

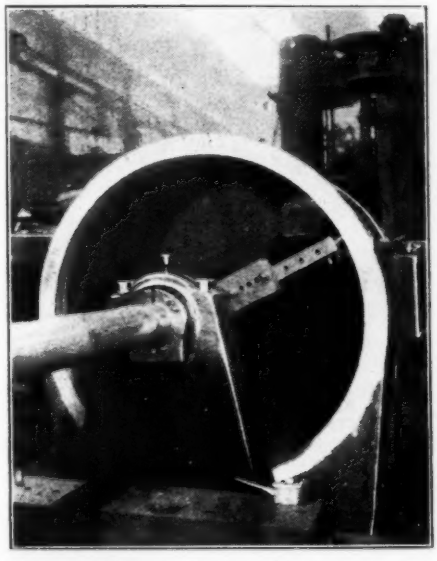


Fig. 2.—Marine Engine Cylinder in the Boring Machine.

Fig. 3.—Mould for H.P. Cylinder showing Position of Steel Tube and Chills.

* A Paper read before the Newcastle Branch of the Institute of British Foundrymen, Mr. M. B. Herbst presiding.

parts adjacent to each other. Moreover, a thin part adjacent to a thick part will, under ordinary circumstances, draw metal from the thick part owing to the quicker cooling of the thin part,

Fig. 4.—Group of Chills for Cylinder Cores and the Mould.

leaving a spongy place at the junction of the two parts. This, in my opinion, is the cause of many castings failing under water test."

It is not every foreman moulder who has the

Fig. 5.—Set of Cores for a H.P. Cylinder, with Chills in Position in the Centre Core.

opportunity of seeing the pig-iron come in by rail and, after the castings leave his hands, to follow them through the various departments, until he sees them put into the ship, a finished engine.

Fig. 6.—M.P. Cylinder Mould showing the Square Foot Core in Position.

In passing through the shop he looks for the castings which give the most trouble and anxiety, namely, cylinders. If, when the casting is put on the marking-off table in the machine shop, it is all right, he does not hear anything. He waits, therefore, until the machine man has had his turn at it and that is where trouble may be expected.

Fig. 1 shows a number of cylinders at various stages of machining, and Fig. 2 an L.P. cylinder, 72-in bore, on the boring machine.

When one first examines the bore of a cylinder

Fig. 7.—M.P. Cylinder Mould showing the Blank Chest with Chill Marked in White.

it may be thought to be perfect, but, on closer inspection, it may be found that the metal is more open-grained in some parts than in others. A search for the cause is liable to centre round the outside of the cylinder, the feet, brackets, and indicator bosses, and the question arises

Fig. 8.—M.P. Cylinder Mould, with the Foot Core in Position.

"Are these the cause of the trouble? If so, what can be done to overcome it?" In the erecting shop, the casting is drilled, fitted, closed up and tested under water pressure, and again one may look for trouble and perhaps find it in the shape of "weeping."

Many foundrymen, when visiting the North Eastern Marine Engineering Company's foundry

in 1922, saw an H.P. cylinder-mould, finished in the pit, with a steel tube in the indicator boss, instead of a core. Some asked why it was there —many passed it by. The men concerned have stated that it saved both time and trouble, and, consequently, money, by casting it in that part of the cylinder; so much so that the author has orders to use them wherever possible. The bore of the tube, being the size of the required hole, does not need to be drilled into the thick sections joining the body of the cylinder—where trouble

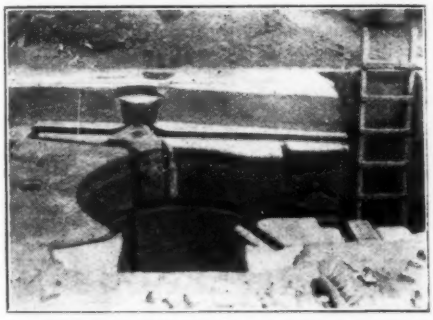


FIG. 9.—M.P. CYLINDER MOULD VIEWED FROM REVERSE POSITION TO FIGS. 6 AND 7.

is met. After seeing some hundreds of marine cylinders pass through the shops, the author has found most of the trouble met with is where the body joins the crown and the column feet join the body. All this may be prevented by making the castings crown-down, but, as this is a question for the engineer, with regard to cost and time, this method is only carried out under special arrangement. Other methods of dealing with these troubles is the subject of the Paper.

These are some of the troubles, that every foundryman is up against, which the author has tried in some small way, and, he thinks, with some success, to overcome. It was during a visit to a foundry in Birmingham some years ago that he noticed pieces of plates on the faces of some small cylinder cores, and, not wanting to show his ignorance, he kept his eyes open to follow them. The men were seen closing a mould and the author noticed that these plates were set in the cores to meet any cross-sections and thicker parts connecting the barrel of the cylinder with the other parts of the casting. Again, in going through the machine shop, similar castings were seen in the finished state, and with a perfect bore. The castings were for high-speed engines.

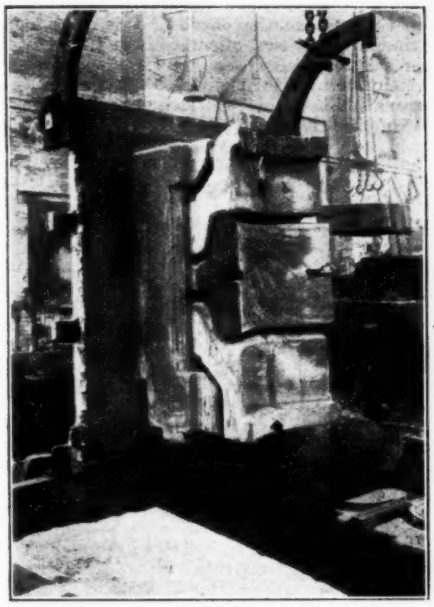


FIG. 10.—STEAM CHEST CORE BEING LOWERED INTO THE MOULD.

They had had trouble with open patches in the bore and that was how they overcame it.

The problem was, however, the employment of similar methods but the high-speed engine castings were much smaller than marine engines and all cores were rammed up in core boxes. Apparently it presented a difficult proposition to apply it to cores built up with bricks and loam and a sweeping board and, therefore, it was decided to tackle the job from the outside of the casting.

The first attempt was an H.P. cylinder, and the author informed the two men making it what he wanted to do, and aroused their interest in the

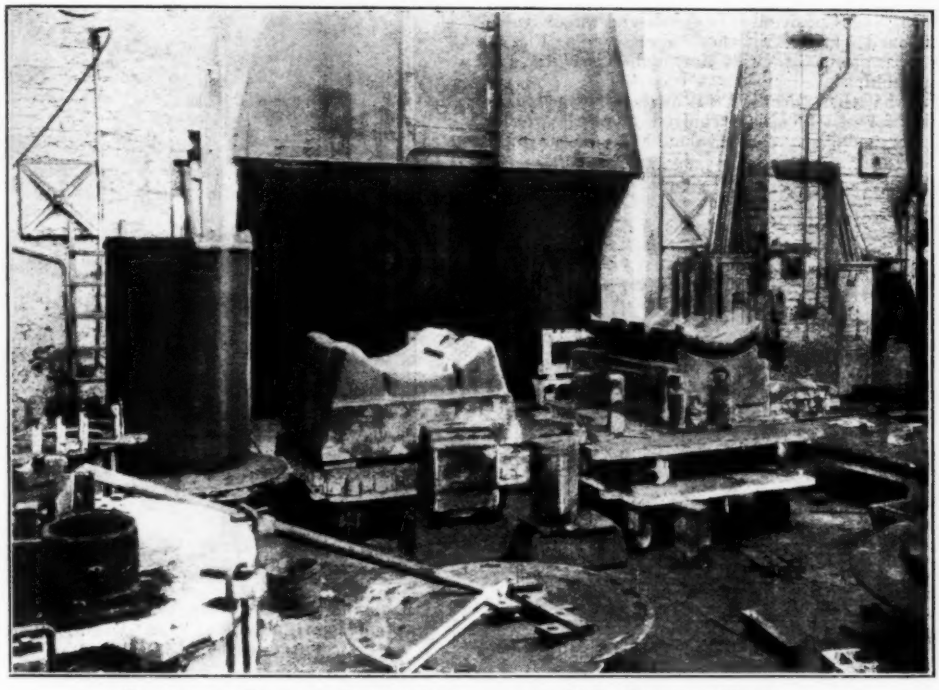


FIG. 11.—A COMPLETE SET OF CORES FOR THE M.P. CYLINDER MOULD.

experiment. The first chills used were pieces of broken grates; something like the fillet required where the cylinder foot joins the body. These were placed in position with each ramming of sand, and, when the mould was being finished, they were shaped off. As it was necessary to wait some time to see the effect of this, the foundry continued with the other cylinders and waited for results.

Attention was then given to the cores to see where a chill would be of some use, and, as the seat of the liner is the heaviest part, it was

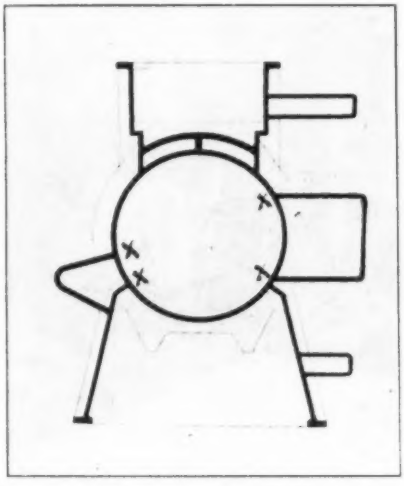


Fig. 12.—Section of M.P. Cylinder showing Position of Chills at X.

thought advisable to try chills in the cores to meet those on the outside. These core chills are made so that they can be built up with the core.

In Fig. 3 is seen the mould of an H.P. cylinder, showing the position of chills and steel tube, mentioned earlier in the Paper, while Fig. 4 shows a group of chills for cylinder cores and the mould.

It was then decided to have some patterns made for the chills required for the other cylinder moulds. These should be of a fairly

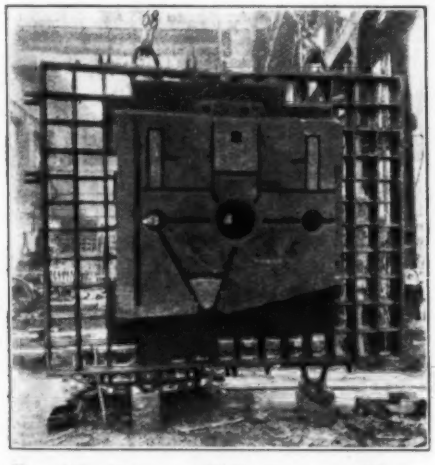


Fig. 13.—Cope for M.P. Cylinder Mould.

standard size, if possible, and always kept in stock, so that the moulders can just stamp a few in the bed along with their grates. Fig. 5 is a view of a set of cores for an H.P. cylinder with chills in position in the centre core.

The M.P. and L.P. cylinders may be treated in a similar manner on the outside of the casting, but with a different chill for the centre core.

Figs. 6 to 9 are photographs of M.P. cylinder moulds, in which can be seen the steel tubes. Fig. 6 shows the square foot core in position; Fig. 7, the blank chest with chill marked in white; and Figs. 8 and 9 are of the other side of the cylinder, showing round foot cores in place.

After a time a marked improvement was found on the outside of the feet joining the cylinder, but, as the inside of the feet was not what it should have been, some straight bars were cast and these were wired on to the grates for the foot cores and left bare except for a coat of blacking. These answered the purpose very well, and now the fettlers seldom, if ever, have to put a hammer on to such parts.

In Figs. 10 and 11 are seen, respectively, the steam chest core being lowered into the mould and a complete set of cores for M.P. cylinder with chills in position in centre core and in feet cores.

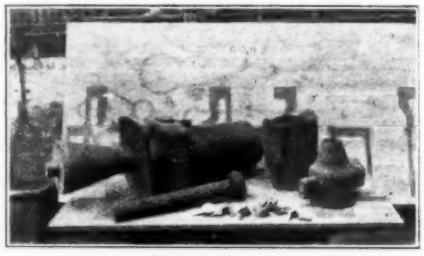


Fig. 14 shows the Pattern, Cores and Chills for an Exhaust Valve.

Fig. 12 is a section of an M.P. cylinder taken immediately under the crown, the points marked "X" being those where the chills are used to counteract the effect of the thickness of metal at the junctions, and Fig. 13 shows the top part of an M.P. cylinder mould.

Of course, it is not claimed that, even with these

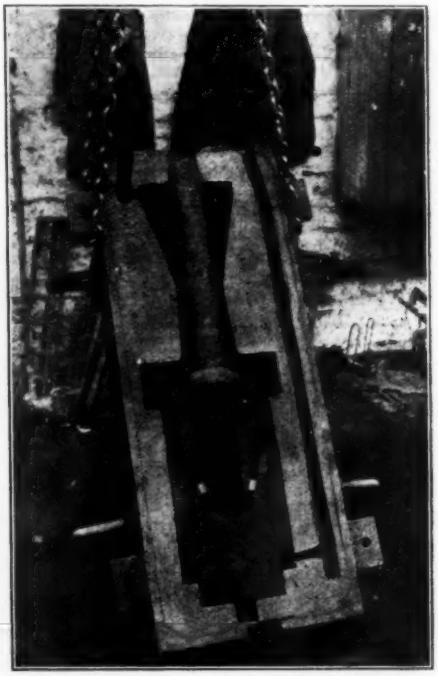


Fig. 15.—Mould, with Core in Position, Illustrating the Large Variation in Metal Thicknesses.

methods, perfect castings are made, but they are undoubtedly better than they ever were before. With the use of chills or denseners many failures and difficulties met with in the foundry can be overcome.

Another casting on which to use chills is a very important part of an oil engine, namely, the exhaust valve. These castings, when in the cylinder head, are subject to the full temperature of the exhaust gas, whilst having cooling water circulating through at the same time. There is a chance of the water coming through the thin wall

of metal into the spindle chamber. This, of course, is bad and must be prevented, and, after cutting up a casting, it was found that the thinner parts were pulling the metal away at the heavy flange, making it too open to resist the water pressure.

It was decided, therefore, to try what effect chills would have upon that part. A plaster of paris pattern was first made out of the half-core box, with allowance for half-an-inch of sand between the two chills, but it was found that, to get them out, they would have to be cut into sections. In the complete core there are six pieces of chills. These are placed in the core box and rammed up with the core, leaving a small portion of sand between each chill. When dry, a single wire is fastened round them for safety.

Fig. 14 shows the pattern, cores and chills for an exhaust valve, and Fig. 15 a mould with core in position, which illustrates the considerable differences in thickness of the various parts of the casting.

It was also found that the nip on the top and bottom of the chills made it very difficult to get them out, so a groove was cut in the pattern to allow them to be broken out. The chills quite overcame the trouble on that particular part, but it was found in another part, namely, on top of the flange, so it was decided to chill that as well.

The first chills on that part were made 1 in. thick, but the castings were too hard to machine. It had to be machined behind the chilled metal and broken off. The chills were then reduced down to $\frac{3}{8}$ in., and this had the desired effect. They were quite machineable and perfect under water pressure. The foundry now makes large numbers without any trouble, and the cost of the chills is nothing compared with that of a replace casting.

Only the practical side of this subject and that within the author's own experiences has been dealt with. From what has been done, the author is convinced that if foundrymen had the chance of seeing their castings undergoing the tests required of them, many failures could be saved with little, if any, extra cost.

In conclusion, the author desires to thank the North-Eastern Marine Engineering Company for allowing him to give this Paper, and also Mr. H. J. Young, F.I.C., for his assistance in preparing the illustrations and slides.

DISCUSSION.

MR. HERBST opened the discussion, saying that they had listened to Mr. Frier's Paper with great profit. He was of the opinion that chills would not have been required in the first place had the engineer not been at fault. The engineer often gave the foundryman a drawing in which the sections were not symmetrical, and in that case chills *had* to be used. At his firm they had found that chills were not effective in places where there were joints.

With regard to the head on a casting, his experience was that a head of about 3 in. was equally as good as one of, say, 1 ft.

MR. EDWARD SMITH thought that, as a rule, metals could be mixed in such a way that chills were unnecessary. There was no doubt, however, that chills would be an advantage, probably, where there were large fillets.

The lecturer had shown a photograph of the core of an H.P. cylinder where there were three or four chills round the top, and he wondered what effect those chills would have upon the machining qualities of the metal. In the majority of cases if, when the casting was sent into the fitting shop, there was any difficulty with the tool jumping a little, the foundry heard about it.

In reply, MR. FRIER said that there were no chills on the parts of the cylinder which had to be machined. The effect of a chill depended upon its thickness, *i.e.*, the thicker the chill the deeper its effect. The metal round about the chill was sometimes about 5 in. thick, whilst the chill at that part was only, say, $\frac{3}{4}$ in., so that the effect upon machining would hardly be felt and the chill would merely close up the grain of the iron at that point. The chill was not carried right down to the bottom, as there is a recess for the liner.

MR. EDWARD SMITH asked if the effect of the chills upon the iron was to cause whiteness.

MR. FRIER explained that in the particular case in question the casting was made of special close-grained iron, and the effect of chilling was greater than in the case of an ordinary open-grained iron.

Casting Cylinders Crown-down.

MR. JAMES SMITH remarked that he had listened very carefully to the Paper, and he could not help feeling somewhat surprised to find that Mr. Frier was using chills. Years ago, of course, they had never thought of using them in certain classes of castings, and one would naturally think that the science which had come to the fore in the last few years would be sufficient remedy. The lecturer had mentioned that they might cast the cylinders crown down, but that it would be an expensive procedure. In his (Mr. Smith's) opinion, to cast a cylinder crown down was undoubtedly the correct method, and he was not so sure that it was the most costly one in the long run, because if, when a cylinder arrived in the fitting shop, there was trouble, it sometimes cost more to put right than it would have cost to mould it crown down.

During the past 15½ years his firm had made castings for about 250 engines, and each H.P. cylinder had been cast crown down, with a head according to the size of the casting, say from 15 in. to 2 ft. 6 in., and he could say, without fear of contradiction, that they had never had a failure with one of those cylinders. In his opinion, the proper way to make a cylinder, even when using chills, was to cast it crown down and to put a sufficient head on it to feed the casting. If there was a leakage in the cylinder it was either at the feet, the indicator boss or the crown. It was pressure that was wanted, and it was pressure that the cylinder received when cast crown down. He felt confident that, rather than have to run risks, it was much simpler for the foundry, and more accurate, to make the castings by that method, and it was the only way to overcome the trouble.

MR. FRIER agreed with Mr. Smith that the perfect way to make a cylinder was to cast it crown down. Since he had been with his present firm they had made castings for about 2,000 engines, and although they themselves made all the cylinders crown up, it did not alter the fact that the other method was the more perfect one. Of course, he was not able to speak upon the extra work and expense entailed. In their present method they used chills, and he thought it was quite evident, from what other speakers had said, that they met the same trouble where there were junctions of metal.

The cost of making chills was practically *nil*, as they did not have to alter the design of the cylinder, and they had certainly proved the benefit of them.

MR. JAMES SMITH pointed out that, when he had referred to expense, he had not meant the cost of the chills, but that, when the casting arrived in the fitting shop, a tremendous amount of expense was often incurred in patching it up. Would it not pay to cast the cylinder crown down, and so get a sound casting in the first place?

MR. E. WOOD, B.Sc., said that they had already considered the question of casting cylinders crown down, but that it meant scrapping their patterns, which was a considerable item. That was probably the only thing which prevented them from making the castings by that method.

Choice of Chills.

MR. H. F. CLEMENTS drew attention to the fact that the lecturer had not mentioned what depth of chill he used on the particular parts of the cylinders. He, personally, would imagine that the deeper the chill the greater would be the amount of heat extracted from that particular part. He inquired how Mr. Frier decided upon the depth of the chill, and whether it was simply by experience or by some more definite method. He asked if the lecturer had experienced any ill-effects from strain, due to using too large a chill on one part of the casting, and thus getting an adverse effect to that desired, causing the casting to crack during machining. For instance, if there was a heavy chill on the core and a heavy chill on the mould, the rest of the mould would cool more slowly and the metal would be drawn from that section. When

the whole of the casting had cooled down there would be a strain there, although there was probably nothing to see.

In reply, the Lecturer stated that the effect of the chill depended upon its thickness. It was hardly possible to see the effect of the chill upon the metal unless it was cut into sections. He did not see how there could be any strain, as the chill was quite free; also the amount of heat in the mould would prevent a strain taking place, as before very long the chill would be at the same temperature as the casting. One might get a bad effect, however, by using a chill too many times, in which case a certain amount of gas arose from the chill, due to its having been heated too many times. For the outside of the casting a chill can be used a good many times, but for a part which has to be machined a chill should not be used more than three or four times. When the chill commences to crack it should be scrapped.

Scientific Aspect of Chills.

Mr. H. J. Young, F.I.C., said that many people did not seem to quite understand what they were doing when they were chilling metal, and seemed to look upon it as a kind of practical thing about which the chemist knew nothing. Also they seemed to think that if a foundry had a chemist they should not be using chills. He did not think that there was anything unscientific in a chill. Whichever way the cylinder was cast, if there were different thicknesses of metal, how was the foundryman to get them alike? There were only two ways of doing it, and one was by using denseners. If chills were not used where there were different sections of metal, the iron would vary considerably when solidified. He supposed founders would say that the chemist should make his iron hard enough to get over the difficulty, but even if the iron was very hard there would still be variations in strength and hardness where there were different thicknesses of casting.

He had consolation in the fact that he had seen many castings made by other foundries, and found that they all suffered from the same troubles. It seemed to be only at meetings that people made all good ones.

He was in entire agreement with Mr. Smith about casting a cylinder crown down, but at the same time the use of chills applied to that method as well as to the other.

In the modern engine it was essential to get every part of the castings alike. The Germans had discovered a wonderful process for accomplishing that very thing, namely, the making of all sections of a casting exactly the same. It was impossible to do it by metal alone, and therefore the only alternative was to use chills or else this German process, and chills had very great limitations and disadvantages.

Some of the members had been talking about porosity and blow-holes in castings, whilst others had referred to the density of the metal. If the cylinder was cast crown up there was bound to be trouble with blow-holes and at the important parts of the casting at the top of the mould. Chills would do no good in these respects. When cast crown down the gases and dirt rose to the top of the mould, namely, to the unimportant part of the cylinder. Also the important parts were "fed" by the metal above acting as a "head."

Mr. James Smith said he would like to know why Mr. Frier had used chills in the first instance.

Responding, Mr. Frier said that after the castings had been machined he had the opportunity of seeing that there were different sections of metal, and that the grain was not all the same. It was to overcome this and to close up the grain of the metal at these sections that he had tried the effect of chills. The chilling might not close up the grain of the iron on the inside as much as desired, but if it closed up the grain on the outside it would give some benefit, and it *had* done so. The chills had certainly served their purpose. He had knowledge of many castings where they had effected a great improvement.

Mr. James Smith said that his point was that if it were possible to get a sound cylinder by casting it crown down, why bother with the use of chills at all? Mr. Wood had stated that casting cylinders crown down meant scrapping the patterns. He (Mr. Smith) did not think that this was at all necessary.

The Lecturer said that they were all of the same opinion as Mr. Smith, namely, that to cast a cylinder crown down was the more perfect method, but nevertheless it was not the one they were using, and what he was trying to do was to remedy the difficulties in their present method. Everyone knew that the bottom part of a casting was always the soundest part, and it was only natural therefore that to make a cylinder crown down was going to give a better casting.

Object of Chills.

Mr. W. J. Paulin said they all remembered the lecture M. Ronceray gave to the Newcastle Branch. In this lecture it had been pointed out that, if greater attention were paid to the methods and rate of pouring, very much sounder castings would be obtained, and that the use of chills could be done away with. He (Mr. Paulin) could hardly agree with M. Ronceray on this point, because, as Mr. Young had pointed out, there was the difficulty of the different sections of metal to contend with. It was impossible to get these different sections the same when cooled unless chills were resorted to. One experienced the same thing in tempering tool steel.

He would hardly put it as Mr. Frier had, namely, that the chill was used to close up the porosity of the metal, because he thought that it was more to hasten the period of cooling in a particular place that really mattered. When defects were present in a casting they were generally found at the junction of sections where the metal was thick, and, consequently, took longer to cool. If one could get uniform cooling conditions of both thin and thick sections, then the demand of the thin section for more metal from the thick section ceased.

There were many advantages in the use of chills, and these had been touched upon by Mr. Frier. The lecturer had shown a section of a cylinder where the junction took place between two sections running towards the cylinder bore. Care had been taken by the engineer to separate these two sections and to form a fillet, but, as Mr. Frier had quite rightly pointed out, such a fillet was very difficult to maintain in sand. By chilling he had not only produced a very uniform section, but he had got more uniform cooling, which meant that the junction was made perfectly sound. What he (Mr. Paulin) liked about chills was that they provided a margin of safety.

He had had the same experience as Mr. Frier, only with smaller castings, and they had had ample evidence that chills overcame the trouble entirely. They had first tried to alter the mixture by reducing the silicon, and although they got a very close-grained iron there was still a leakage in the cylinder, but the application of chills had removed that entirely. Chills did not produce the effect that many people thought they might, namely, produce hard spots. If the thickness of chill was carefully determined beforehand it brought about all that was desired in the way of hurrying up the cooling without altering the machining qualities of the iron.

Mr. Frier was correct in mentioning that a chill should not be used too many times. Although there was nothing visible in the chill to show that it was defective, if it had been used too often it would give off gases. That was almost the only point which he thought required watching, and it was quite a separate question from that of undue thickness of chill.

Mr. Wood said that the argument seemed to have been raised against the lecturer that he was using chills to save castings from the scrap heap. Mr. Smith had overlooked one fact, however, and that was that the lecturer had shown on the screen at least one core where the chills had not been used to resist porosity, and he would like to hear the lecturer express his opinion upon those chills.

Mr. Frier explained that in the particular casting which Mr. Wood referred to they had gained experience from the trouble which other people had had, the casting not being one of their own making, but from another firm. They had cut it up, and had been able to overcome the trouble successfully by applying chills.

Discussion on Mr. E. Longden's Paper on "An Analysis of Defective Castings."*

EAST MIDLANDS BRANCH.

MR. RUSSELL, opening the discussion, said as regarded the shortage of metals he remembered an amusing instance when the foundry was casting handwheels flour was used for dusting the moulds. One ladle would cast two wheels. One day the moulder found, to his amazement, that the mould did not fill, though he emptied the full ladle in. Another tried, and still the mould was not filled, until someone called out that the metal was running into the ashpit, and on examination disclosed the fact that a mouse had entered the mould after the flour and had eaten its way out the other end, and through the hole the metal was escaping. In respect of gas and blow-holes innumerable points arose, and Mr. Longden had emphasised that hot pouring was the cure for many of these troubles, and he was convinced that was so, but one must make a suitable mould, and he did not mind so much about a rough skin if the casting was to be machined. How did Mr. Longden reconcile his statement and example of top running with the fact that active running is detrimental to the actual casting as it causes gas and blow-holes. Then as to wasting of blacking and plumbago, the moulders insist that it is not so sticky as it used to be, and does not adhere to the sand so well. A large percentage of wasters were due to the metal swilling the blacking along and leaving it on the casting in little rippling waves. He thought much depended on the way the metal was melted, and foundrymen who were out for a low coke consumption would be liable to get a considerable increase in wasters. Then metals—non-ferrous metals particularly—vary, and a great deal depended on the skill of the moulder, and to some extent on the quality of metal, and one could not state that what was true of one works equally applied to another.

MR. J. LUCAS said the information given showed the value the Institute was to all engaged in foundry practice. They were able to take advantage of the experience of others.

MR. BUNTING said there was one point he was not altogether in agreement with Mr. Longden with regard to porosity. He was very definite on the point that it is due more to gases from the mould or the cores than from any other causes. They were also up against the trouble of segregation. With a perfectly dry sand mould one got porous spots, and he did not think this was due to anything other than the impurities in the iron. These things had, to a great extent, to be overcome by the use of denseners, and if it were entirely due to the gases the denseners used would not help. The densener does shift the gases which are there. He agreed that to a great extent many scabbings were due to faulty vents.

Cylinder Cores.

MR. RUSSELL said it was their habit to pack the barrel at the top. Mr. Longden had said expansion of the barrel will tend to distort the core, but they had still to get their first waster from that cause. They may have been lucky, but he would like Mr. Longden to elaborate the point, as it might be interesting to other members to know whether the risk was really serious or not, as Mr. Longden had experience of larger works. He regularly made castings up to 10 or 12 ft. in depth, the barrel had been 12 ft. long, and as far as he could recall there was not an instance where they had had trouble traceable to the fact of the barrel packed at the top and bottom distorting or cracking the core.

MR. LONGDEN, in reply, said he was referring only to rammed castings—the one was 30 ft. long, and was a long cylinder core with the barrel fairly close to the sides of the mould. Mr. Russell had pointed out that hot pouring, or at least hot melting, was essential. The extraordinary amount of labour a moulder puts into his work was due to the conditions and materials he had to contend with. In regard to pouring from the top the agitation ensured the scum floated on the top and ran into the head. If a casting is poured from the bottom active work is precluded from taking place. It was a fallacy to think dirt comes to the top—it stuck on the mould and the core, and that was why he ran this type from the top. With regard to blacking cores whilst hot, he did not say it was not right to do so; he only said that scabs are sometimes formed that way. It took too much blacking, and the blacking should be silvered to suit the temperature of the core. Mr. Russell in the end did agree as to the efficacy of the vent wire. His (the speaker's) only point was, and Mr. Russell had pointed out, that if there was not ample exit for the gases it was a great source of scabbing. In respect of Mr. Lucas's question of the temperature for drying oil sand cores, they would dry at normal temperatures, but the heat should never exceed 400 deg. C. He agreed that core oils are certainly legion. He did not see yet how they could have a standard system of core prints as mentioned by Mr. Stevenson, but he thought they could introduce standard colours.

MR. E. STEVENSON moved the vote of thanks, and MR. W. A. STREET seconded, the LECTURER briefly replying.

DISCUSSION AT CARDIFF.

MR. HIRD, referring to blow-holes in castings, said one way not mentioned by the Lecturer was that air might be carried into the mould when pouring, but if poured with hot iron the casting will have a fair chance of turning out free from holes and defects. Another cause of blow-holes is pouring too far away. He was confident that quite a number of little blow-holes are caused by dull iron and high pouring. Then again, pipe nails and chaplets are a prolific source of trouble, especially on machining faces. Faulty chaplets give off gases. A large liner showed spongy patches, and it was decided to put a densener around the thick part. These were fixed on the core in segments and bound with wire. It was suggested that the wire should be taken away, but it was insisted upon that it would melt. However, the wire showed a thin line all round the casting, which had to be scrapped.

MR. JENKINS said that there were three essentials for good moulding; hot iron, suitable runners and the proper use of the vent wire. He had noticed that sometimes, instead of runners being made parallel, the moulder would go down 1 or 2 in., with the result that when the metal was poured into the mould it whirled and was sucked down, and there were dirty places somewhere. Hot iron allowed of more chance of the pressure overcoming the pressure of the gas, and so eliminating it. By hot iron the speaker meant yellow superheated iron, and with this it can be cooled down to the temperature required.

Answering Mr. Jenkins as to whether for cylinder liners, bottom- was preferable to top-running, the LECTURER said that with medium or small sized liners there was not the slightest risk in running the whole of the metal from a top grate, as the dirt was then kept moving.

MR. MCCLELLAND said that as long as metal remained in a liquid state it was always casting off some kind of slag, and there must be some way of arranging for the escape of the apparent refuse. He did not think he had ever seen absolutely pure metal, and difficulties arose which were more for solution by the metallurgist than the foundryman. He agreed that slag did not always rise to the top, and this was a debatable point which depended largely upon the condition of the metal. If the metal was sufficiently hot, he thought that the dross would work up to the surface. There was also the question of faulty coke, which often contained more sulphur than was good for iron, and caused more difficulties for the foundryman to overcome, but these problems, however, should remain in the hands of the chemist and not be left for the moulder to overcome.

MR. LONGDEN agreed that hot iron and vent wire were essentials, and his advice would be, very rarely run with dull irons. Moulds made to stand hot iron will give very little trouble. Much damage can be done by the over-use of vent wire, scabbing and blow-holes being caused. It has been said that coal dust helps venting, but, in his

* See issues of March 5 and 12.

opinion, this helped to create gas, and the point was to free the moulds from gases.

Replying to Mr. McClelland, Mr. Longden said that 95 per cent. of the trouble caused through slag lies at the door of the moulder, where good melting practice is in vogue. It was essential to melt the metal hot, and not to pour dull. If dull metal was required for any special purpose, first melt it hot and then cool it down.

Ancient Metal Workers' Blunders.

By H. Littlehales.

Workers in metal, like the rest of mankind, are not immune from the making of mistakes.

Sometimes the inscription to be set on a vessel is too long, and the last word or part of it has to be left out and trusted to the imagination of the reader. An instance of a curious mistake in the inscription on a beautiful vessel, a unique example of a mediæval ewer cruet in a church in Guernsey, may be seen where the inscription reads:—"*Sancte Paule ora pro nobis.*" But the workman, by whom the inscription was set, had a narrow escape of perpetrating a lamentable blunder, for after "Sancte Paule" he, having either the word "pray" (the English equivalent for the Latin "ora") in his mind, or the thought of the "P" just written for Paule, set again that letter "P" when he should have put "O" for Ora.

In vain did the poor fellow try to obliterate the letter. "P" still remains, only partly scratched away, to tell the tale to-day of a momentary forgetfulness.

Another example sometimes made by workers in setting inscriptions is in the forming of the letter "N," which sometimes appears with the oblique stroke from the top right stem slanting down to the foot of the left stem—thus И. Another and somewhat similar error—but this is not common—is where "M" appears as an inverted "W," this displayed in sprawling form as ʍ.

In the case of the cup or chalice at the church of Deane, in Hampshire, the workman has by mistake left out an "N," with the consequence that the inscription reads:—"*Give God Thakes For All.*"

In another inscription set on a vessel in Rochester Cathedral the Latin word "*spiritu*" has been muddled into the contracted form of "sper." "Spir" one could understand as a form of "spiritu," but "sper" is a mistake; an excusable one, and just possibly not due to the worker. There is, too, the omission of a letter "C" in a paten at Wyke Church, near Winchester, failing to make its appearance.

Mr. Tyack, in his excellent book about bells, writes on this point:—"We find, for instance, inscriptions entirely reversed, as at All Cannings, Wiltshire, where "Anno Domini, 1626," appears as "6261: in: im: od: on: na." The name "Sancta Helena" is given on a bell at Dunsforth, Yorkshire, as "An el ehat enas." A bell at Molton-le-Clay, Lincolnshire, has the letters mingled according to no rule, so that what was meant for "Sancti Petri" appears as "Sanc irt ep it." At Clapham, Bedfordshire, one word of the inscription is upside down, thus: "God save the Church."

Often mistakes and omissions are due to miscalculating the spacing. The workman starts with the idea that twenty cusps for a cresting will fill the space he has. But when the work is being put together he finds that twenty cusps are a little too much.

To rectify this he places two cusps close together, and the mistake is not readily discernible, and, oddly enough, it does not materially affect the beauty of the article. The cresting of sugar-basins sometimes exhibit these mistakes.

Mr. Cripps, in his "Old English Plate," points out that the inscription on a paten found in a tomb at Canterbury has the letter "N" placed upside down.

Sometimes mistakes appear to be due to sheer carelessness, as, for instance, in the brasses at Avisham Church, in Norfolk, where the thumbs on the hands have been omitted, as is illustrated in "Suffling's Brasses."

Reaction between Manganese and Iron Sulphide.

According to a Paper recently presented to the American Institute of Mining and Metallurgical Engineers by Messrs. C. H. Herty, Jr., and O. S. True, it is a well-known fact that manganese will desulphurise molten iron through the formation of manganese sulphide, which, being only slightly soluble in the metal, rises and enters the slag where it remains as such (mixer slag) or is converted partly or wholly to calcium sulphide (basic open-hearth slag). The reaction by which manganese sulphide is formed is Mn + FeS = MnS + Fe. This reaction is generally considered to be reversible, although McCance states that such is not the case. The experimental work was carried out to confirm the results of Röhl as to the reversibility of the reaction.

Six trials are considered in the Paper. In each 200 grammes of electrolytic iron free from manganese and sulphur were melted in a pure zirconia crucible in a carbon-resistance electric furnace. To the melted iron in runs Nos. 2, 3 and 4 metallic manganese and manganese sulphide were added to give 1, 2 and 4 per cent. manganese respectively, with 0.50 per cent. of sulphur in each. In runs Nos. 5, 6 and 7, metallic manganese and iron sulphide were added to give the same proportions of manganese and sulphur as in runs 2, 3 and 4. The melts were held molten in the furnace for 1 hr. and then cast into ingots.

The results of these melts are as follows:—

Run.	Material charged.	Ingredients of charge.		Analysis of Ingot.	
		Manganese.	Sulphur.	Manganese.	Sulphur.
		Per cent.	Per cent.	Per cent.	Per cent.
2	MnS + Mn	1.0	0.452	0.636	0.367
3	MnS + Mn	2.0	0.50	1.57	0.310
4	MnS + Mn	4.0	0.50	2.81	0.230
5	FeS + Mn	1.0	0.50	0.647	0.397
6	FeS + Mn	2.0	0.50	1.45	0.374
7	FeS + Mn	4.0	0.50	2.73	0.195

The results show that manganese sulphide, even in the presence of an excess of manganese, will be converted to iron sulphide and enter the metal, the reaction, therefore, being reversible. Further, the greater the excess of manganese, the lower the sulphur in the metal, regardless of whether the sulphur is originally present as MnS or as FeS. Comparing the tests made with the same concentrations of manganese and sulphur in the charge, but with the sulphur charged as MnS in the first case and FeS in the second, we have:—

Run.	Material charged.	Charge.		Ingot.	
		Manganese.	Sulphur.	Manganese.	Sulphur
		Per cent.	Per cent.	Per cent.	Per cent.
2	MnS + Mn	1.0	0.452	0.636	0.367
5	FeS + Mn	1.0	0.50	0.647	0.397
3	MnS + Mn	2.0	0.50	1.57	0.310
6	FeS + Mn	2.0	0.50	1.45	0.374
4	MnS + Mn	4.0	0.50	2.81	0.230
7	FeS + Mn	4.0	0.50	2.73	0.195

From these results, it is evident that equilibrium had been established, for regardless of the charging conditions, tests with equal concentrations of manganese and sulphur in the charge should come to the same final concentrations if the reaction FeS + Mn = MnS + Fe is reversible.

Sections of the ingots from runs 2, 3 and 4 showed that as the manganese excess increased the inclusions became darker, showing that the ratio of manganese sulphide to iron sulphide increased. This was to be expected as the equilibrium constant or ratio for the reaction is

$$K = \frac{(\text{MnS})\ \text{metal}}{(\text{FeS})\ \text{metal} \times (\text{Mn})\ \text{metal}}$$

from which it can be seen that as the concentration of manganese is raised the ratio $\frac{(\text{MnS})\ \text{metal}}{(\text{FeS})\ \text{metal}}$ must increase.

The loss of manganese over that required to form MnS was the result primarily of oxidation of manganese, the electrolytic iron containing 0.44 per cent. oxygen as surface oxidation picked up during pulverising.

Iron-Cementing Compositions.*

Some Practical Recipes.

Utility of Iron Cements.

Of course, it is impossible to effect any satisfactory repair, by means of the use of cements, to such objects as iron or steel shafts, but there are numerous cases in which the use of a cement has meant the saving of considerable sums of money. A broken part in a machine or tank may be temporarily repaired, and there is no need to suspend operations until a new replacement part is obtained. Very little information has hitherto been available on this subject, however, so that it should be of interest to reproduce an article that Dr. P. Martell, of Berlin-Johannisthal, has contributed to a recent issue (February 19, 1925) of the "Chemiker Zeitung."

General Working Directions.

Iron cements, he says, have always found a fairly extensive use in foundries, where their application has made available a means for smoothing-over rough places in castings and for similar purposes. Their use for repairing machinery parts has not been so large, principally because it has not in general been attended with a sufficient measure of intelligence or knowledge. In any case in which it is hoped to make a satisfactory cementing job, every care should be taken to see that the corners and rough edges of the fractured parts are not chipped off. When the surfaces to be joined together are dusty or greasy they should be well cleaned before the cement is applied. The cleaning material used may be soda-ash solution, caustic-soda solution, acetone, benzine, methylated spirit, or carbon bisulphide, depending upon the nature of the matter to be removed. Or simple fat solvents may be used as the cleaning material.

In the second place, most of the cements are applied to the warmed-up surface of the fracture, and it is most important that the source of heat should be suitable. Oxidising flames or a fire of sulphur-containing coal should be avoided, it being by far better to use a wood-charcoal fire or the flame from a spirit-lamp. The surfaces must be heated before the cement is applied as a uniform and liberal layer. In most cases the cements used do not undergo any great diminution in volume on solidifying, but it is as well to examine any new cement carefully for this property before applying it to the job in hand. When it is at all practicable, the parts being joined together should be subjected to substantial compression. Mineral colours may be incorporated with the cement, but not in quantity large enough to influence the setting and adhesive properties of this latter.

Cements for Iron Castings.

Below are given a number of recipes for iron cements of established value:—

A proved cement which will withstand high temperatures consists of 1 part of powdered borax, 5 parts of zinc oxide, and 10 parts of powdered pyrolusite. The ingredients are mixed together with sodium-silicate solution to form a paste. This cement hardens but slowly.

A useful cement for cast-iron articles is stated by Schwartze to be an intimate mixture of 1 part of borax powder, 1 part of salt, 2 parts of pyrolusite, and 4 parts of finely sieved iron filings. To this mixture is added 10 parts of fine loam and sufficient water to form a stiff paste. In this case the repaired article should not be exposed to the action of heat until the cement has thoroughly hardened.

Another cement for cast iron, particularly suitable for fine castings, is 100 parts of iron in powder form, 1 part of aqueous ammonia, and sufficient water to make a fine, stiff paste. A cement for cast-iron kitchen ovens and similar articles is made from 1 part of iron filings, 1 part of loam, and 1 part of sieved wood ashes, mixed with vinegar to a stiff paste. This cement is particularly useful for mending extensive cracks.

Repairing Distillation Plants and Soap Kettles.

C. Breuer recommends the following cement for distillation plant (for oils and fats) and for soap-boiling kettles: 1 part of dried, finely powdered loam is added to 2 parts of very fine, pure iron filings. Fairly concentrated acetic acid is added, and the whole is kneaded to a plastic mass. It is essential that this cement be used as soon as it is made, since it sets very rapidly.

To remedy flaws in castings Lehner recommends a cement made by mixing 100 parts of pure iron filings with 0.5 part of flowers of sulphur and 0.8 part of salammoniac. Water is added to form a stiff paste. The surfaces to be treated must be well cleaned with soda or ammonia. Another cement for this purpose is made by mixing 130 parts of wrought-iron filings with 3 parts of flowers of sulphur and 5 parts of salammoniac. The mixture is made into a paste with dilute sulphuric acid. This cement is a very good one, and in two to three days sets to a rock-like mass, adhering most tenaciously to the iron surfaces. Another cement for the same purpose consists of 1 part of iron filings, 1 part of flowers of sulphur, 0.6 part of powdered salammoniac and 0.8 part of fine sieved brick. In this case dilute aqueous ammonia is used to make up the paste.

An iron cement particularly suitable for patching-up castings is made by mixing 100 parts of rust-free cast-iron turnings with 1 part of well-dried powdered salammoniac, and then moistening with salt solution. This cement immediately warms up and quickly hardens.

An excellent rusting-type iron cement is the following:—Two parts of iron filings are mixed with 1 part of brick dust and 0.5 part of powdered porcelain waste, and mixed to a stiff paste with a 10 deg. Bé. salt solution. The iron parts to be joined together must be well cleaned, and after the cement has hardened it will withstand high temperatures.

If metal is to be cemented in stone, the following coarse cement is very useful:—Equal parts of iron filings, brick dust, and flowers of sulphur are mixed to a paste with dilute acetic acid, and applied immediately after incorporation. For repairing iron vessels which contain water, a cement made from 2 parts iron filings and 1 part of powdered iron sulphate, rubbed down with strong vinegar to a thin broth, and which must be used immediately after preparation, is to be recommended. The well-known and largely used red-lead cement is made by mixing 10 parts of red lead and 10 parts of linseed-oil varnish.

Steam-Boiler and Steam-Piping Cements.

As a steam-boiler cement, Serbat recommends mixing 100 parts of litharge with 75 parts of powdered pyrolusite and 100 parts of graphite powder. This mixture is then worked up into an easily-kneadable mass with warm linseed-oil varnish. To repair small flaws in iron castings a cement made by mixing 5 parts of Paris white, 5 parts of yellow ochre, 10 parts of ground litharge, 5 parts of red lead, 4 parts of ground pyrolusite, and 2 parts of asbestos powder, is recommended. The mixture is mixed with linseed-oil varnish to a stiff broth. The cement sets in about 4 hours, and possesses practically the same coefficient of expansion as does cast iron. A cement particularly suitable for steam-piping is made by heating linseed-oil varnish and then adding a mixture of 50 parts finely ground graphite, 50 parts litharge, 30 parts heavy spar, and 20 parts fine brick dust, until a paste is obtained.

To the group of the so-called water-glass cements belong the following iron cements:—Forty-eight parts of iron filings, 12 parts of hammer scale, 30 parts of burnt gypsum, and 10 parts of salt are mixed with water glass to a stiff paste. The cement hardens rapidly. A good water-resistant iron cement is also made by mixing 1 part of powdered borax with 2 parts of dried, powdered loam, and, making up with water to a plastic mass. This cement is very useful for steam plant, but the parts to be cemented must be well cleaned. Another good cement is made by mixing 10 parts of fine pyrolusite with 40 parts of fine loam and 50 parts of powdered borax. Milk is used for mixing to a fine paste, and the cement dries (under cover) in 24 hours.

* Chemical Trade Journal Translation.

Trade Talk.

The Government has made a net loss on the Australian zinc concentrates transaction of £1,328,000 as from April, 1918, to March 31, 1924.

The Stepney Borough Council have accepted a Belgian tender of £16,625 for electricity plant. The lowest British tender was nearly £20,000.

In consequence of the continued depression in trade, it was found necessary, on Saturday last, by Alfred Hickman, Limited, Springvale Steel Works, Bilston, to suspend 700 workers.

The Foundry Sales Department of the Staveley Coal & Iron Company, Limited, near Chesterfield, announce that on the 25th inst., their London office addresses will be removed from 34, Victoria Street, Westminster, S.W.1, and St. Pancras Road, to Crown House, Aldwych, W.C.2.

Marshall, Sons & Company, Limited, Britannia Ironworks, Gainsborough, have appointed Mr. W. F. Weston, 346, Foxhall Road, Ipswich, as their representative for industrial power plant only, in the counties of Norfolk, Suffolk, Essex, Hunts, Beds, Herts and Cambs.

A. & J. Inglis, Limited, Glasgow, have an order for two twin-screw cargo motor vessels from the Argentine Navigation Company. The vessels are to be 275 ft. long by 42 ft. beam, with 6-cylinder Harland-B. & W. Diesel engines, constructed by Harland & Wolff, Limited, Glasgow.

Cox & Danks, Limited, 39 and 40, Arcade Chambers, St. Mary's Gate, Manchester, have removed to Parsonage Chambers, 3, The Parsonage, Manchester. The company, who are engaged in salvage operations at Scapa Flow, after only four days' work, succeeded in lifting and bringing into harbour another destroyer on Saturday last. This is the seventh such vessel raised at Scapa Flow.

German concerns have taken three further orders from the British Empire. The Dublin United Tram ways Company have ordered from the German Cable Works Company the necessary cable during the next twelve months; the South Indian Railway Company have ordered 34 tank trucks from the Saxon Railway Carriage Company; and the South African Railway Company have ordered 15 locomotives from A. I. Massei.

The membership of the new Steel House Constructors' Union is now over 1,000. Membership is confined to men and women who have been trained and employed in the construction of buildings other than brick and stone and roads. The subscription will be 1s. 6d. per week. It is proposed to form another co-operative body for training men to assemble the new type houses and to trade in these houses on a non-profit making basis.

Robert Stephenson & Company, Limited, have an order for five 2-8-0 type locomotives from the London Midland and Scottish Railway. Nasmyth, Wilson & Company, Limited, Manchester, are to supply five 4-4-2 tank locomotives for the Fenchurch Street, Tilbury, and Southend section. Cravens Railway Carriage & Wagon Company, Limited, Sheffield, have an additional order for twelve carriages for the Antofagasta (Chile) and Bolivia Railway.

The number of unemployed members on the books of the Central Ironmoulders' Association at the end of last year was only 104, as compared with 582 at the end of the previous year, a decrease of 478. The percentage of unemployed members—1½ per cent.—is the lowest recorded in the history of the Association, which was founded in 1889. The membership of 7,019 also constitutes a record, the increase during 1924 having been 349. The funds at the end of the year amounted to £21,058, representing an increase in twelve months of £7,971.

The Associated Lead Manufacturers, Limited, a combination of some of the leading British lead-smelting firms, has made an offer for the shares of the Brimsdown Lead Company, Limited. Seven ordinary £1 shares of the Associated Lead Manufacturers are offered for each complete block of forty Brimsdown ordinary 5s. shares. For each block of four 7 per cent. preference shares of the Brimsdown Company shareholders are offered two 6 per cent. preference £1 shares and one ordinary £1 share of the Associated Manufacturers. The capital of Associated Lead Manufacturers is £1,850,000, of which 738,521 preference shares and 1,107,780 ordinary shares, all of £1 each, have been issued credited as fully paid to the vendors of the businesses already acquired detailed below in part satisfaction of the purchase price. The balance of the purchase price—namely, £184,226—represented in the main by marketable securities, has been satisfied by the issue to the vendors concerned of 6 per cent. short-term notes at par. The businesses already acquired are Locke Lancaster and W. W. & R. Johnson & Sons, the lead and antimony business of Cookson & Company, and the white lead and lead oxide works of Rowe Brothers & Company, at Bootle.

Personal.

Mr. H. E. Wilson has retired from the board of Cammell, Laird & Company, Limited.

Mr. R. Millar Wilson has been elected chairman of Stewarts & Lloyds, Limited, Glasgow, in succession to the late Mr. J. G. Stewart. Mr. A. C. Macdiarmid has been elected an additional deputy chairman.

Wills.

Hallam, S. W., of Taptonville Road, Sheffield, steel manufacturer	£6,651
Crawford, G. H., of Bromsgrove, Worcs., nail manufacturer	£13,790
Wainwright, A., senior partner in Thomas Wainwright & Sons, engineers, Stalybridge	£40,938

Company News.

Bengal Iron Company, Limited. — Dividend, 8⅞d. per share, less tax.

Butterley Company, Limited.—Interim dividend, 4d. per share, free of tax.

Dobson & Barlow, Limited.—Interim ordinary dividend, 3 per cent. actual.

Howard & Bullough, Limited.—Quarterly dividend 6d. per share, less tax on ordinary.

Metropolitan-Vickers Electrical Company, Limited.—Dividend, 8 per cent., less tax, on ordinary shares.

John Baker & Company (Rotherham), Limited.—Dividend on ordinary shares, 7½ per cent., less tax, for year.

Glasgow Engineers, Limited, 89, James Street, Bridgeton, Glasgow.—Capital £3,000 in £1 shares. Engineers and iron and steel founders.

Mirrlees Watson Company, Limited.—Net profit, £15,131; brought forward, £5,283; dividend, 10 per cent., less tax; carried forward, £5,542.

Pinchin, Johnson & Company, Limited.—Profit, £125,141; final ordinary dividend, 22 per cent. (making 30 per cent. for year), less tax.

Scottish Tube Company, Limited.—Depreciation, £15,000; ordinary dividend, 4 per cent., less tax, for year; reserve, £5,000; carried forward, £16,539.

Maurice Brown Steel File and Tool Company, Limited.—Capital £100 in 5s. shares. Mechanical engineers. Solicitors: Ingledew & Sons, 4, Mount Stuart Square, Cardiff.

British Aluminium Company, Limited.—Depreciation, £500,000; reserve, £120,000; profits, including amount brought forward, £139,321; final ordinary dividend, 15 per cent. per annum, making 10 per cent. for year; carried forward, £21,243.

Alley & MacLellan, Limited.—Balance at credit of trading account, £18,904; brought in, £1,914; available, £20,818; depreciation of property, etc., £10,572; final dividend on preference shares, 5½ per cent. per annum, less tax; carried forward, £6,676.

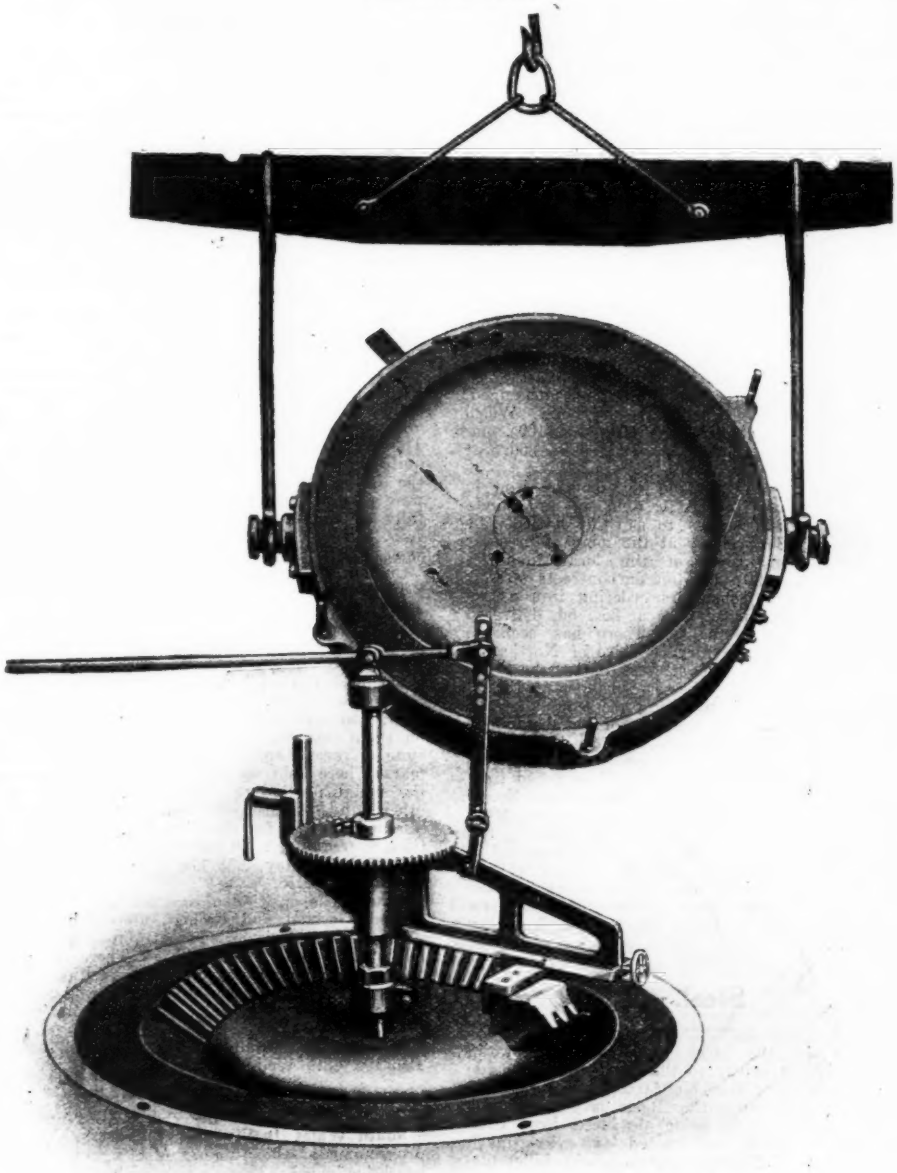
United Alkali Company, Limited.—Net profit, £457,812; brought forward, £102,846; available surplus, £560,658; reserve account, £150,000; final dividend on ordinary shares, 7½ per cent., making 12½ per cent. for year; carried forward, £100,392.

With Sir Alfred Herbert, the president, in the chair, the members of the Machine Tool Trades Association held their annual dinner last week. Amongst those present were: Sir Edward Iliffe, M.P., Mr. H. N. Gresley, Mr. C. E House Mr. D. A. Bremner, Major P. J. Cowan, Mr. W. La Coste, Mr. F. Pollard (vice-president), Sir Benjamin Longbottom, Mr. R. E. L. Maunsell, Sir H. Mensforth, Sir Harry Smith, Mr. N. S. Nugent, Major H. R. Watling, Mr. L. Pendred, Mr. Harold Butler, and Mr. Herbert G. Williams, M.P. (secretary).

Baldwins, Limited, have decided to establish their own organisation in South Africa. For this purpose a subsidiary company has been formed under the title of Baldwins (South Africa), Limited. The first directors include Mr. W. H. Haig and Mr. J. H. Younger, both well-known in commercial circles on the Rand and in Rhodesia. Mr. Younger was for some years in charge of the interests of Fraser & Chalmers, who have represented Baldwins, Limited, in South Africa. Mr. Haig has recently returned to South Africa from a visit to Great Britain, where he concluded negotiations with the directors of Baldwins, Limited, with reference to the formation of the subsidiary company. Last year Colonel Alan Dore, one of the directors of Baldwins, Limited, made an extensive tour of the country. The business will have its headquarters at Johannesburg, with branches at Capetown, Durban, Port Elizabeth and East London.

The "VULCANIA" PATENT WHEEL MOULDING MACHINE.

Patent No. 5049.



THE "VULCANIA" PATENT WHEEL MOULDING MACHINE is for moulding spur wheels with straight, sloping or Vee-shaped teeth, also bevel wheels, skew gear wheels, worm wheels and internal wheels. The machine head is carried on a pillar which is held in a base-plate bedded in the floor sand, and is made to slide on the pillar by means of a lever and link carried on a joint bearing, or by rack and pinion, or screw if thought advisable for the particular work it is being used for.

An adjustable stop collar is provided for accurately deciding the depth of mould. On the removable head a slide is carried for supporting the patterns of the teeth to be moulded. This slide is made adjustable by screw or pinion gearing to the diameter required. The number of teeth to be moulded is decided by a special dividing plate into which a steel wedge or finger engages. The special dividing plate has milled vees, at the angle of 60° inclusive, around its circumference, to receive the steel wedge, which is adjusted by a screw having an internal spring to keep it in tension and to lock the head when ramming operations are being carried out.

JAMES EVANS & CO., BRITANNIA WORKS,

(MANCHESTER), LIMITED,

BLACKFRIARS, MANCHESTER.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—The close of the current quarter marks a little improvement in the general position of the Cleveland iron trade, the depressed conditions recently experienced having become slightly less pronounced. Inactivity of home demand may be attributed to the lack of confidence in the outlook on the part of users of pig-iron. Contracts are running out, but the prospects of work in the foundries are so uncertain that consumers have been contenting themselves with buying small lots from day to day, and have been reluctant to committing themselves ahead. This week, however, there has been more buying, and No. 3 was quoted at 78s. per ton, with No. 1 83s., No. 4 foundry 77s., and No. 4 forge 76s. per ton.

The Tees-side hematite market is also without signs of early improvement, and there is keen competition for the few orders coming on to the market, while prices are very irregular. Inquiry for export is very slow. The current quotation for East Coast mixed numbers is 84s. per ton, but even this figure is apparently unattractive. On the North-West Coast business is again quiet, with quotations unchanged, Bessemer mixed numbers being 90s. c.i.f. Welsh ports, 95s. per ton delivered at Glasgow, 100s. per ton delivered at Sheffield, and 102s. 6d. at Birmingham.

LANCASHIRE.—The demand for foundry iron in this district remains limited in tonnage, and hand-to-mouth buying now seems to be the settled rule with consumers. This policy at the moment presents distinct advantages, some of the local foundries having still to pay 90s. per ton on contracts on forward account, while consumers ordering iron as required can obtain their supplies at 85s. 6d. delivered for Derbyshire No. 3 quality. There has been no further reduction in the furnace price of Northamptonshire foundry iron, but at 74s. on trucks it is about as dear for the Manchester consumer as Derbyshire, while the latter is usually preferred.

THE MIDLANDS.—Consumption of foundry pig in the South Staffordshire area continues on a dwindling scale, with sales mostly of a retail order. Prices evidence a weakening tendency, as will be noted from the appended list of quotations:—Derbyshire No. 3 foundry, 79s.; Staffordshire No. 3 foundry, 80s.; Northants No. 3 foundry, 72s. to 74s. 6d.

SCOTLAND.—No improvement can be reported in conditions in the Scottish markets, buyers at the moment evidently lacking confidence to extend the scope of their commitments, while prices remain nominally on the basis of 86s. 6d. for No. 3 quality f.o.t. furnace.

Steel.

Movements in the steel industry are slow in developing advantageously to the home trade, outside competition remaining the chief factor in delaying the long-hoped-for improvement. Basic billets are very quiet, the cheaper steels being produced from Continental billets, which are quoted at prices much below the cost of English makes. Acid billet demands, on the other hand, show some improvement, and quotations are firm at the old figures. There is a comparatively large production of Sheffield's best steels, a good proportion of which is for export. The home demand for ferro-manganese is exceptionally small, but with the steel trade in its present condition this is not surprising. On Continental and American account the call is a little more active. The question of the continuance of the stabilisation of tinplate prices arrangement has been the subject of a further meeting of the joint committee, and it has now been decided to continue the scheme until October next, the committee meeting some weeks prior to that date to review the position.

Scrap.

Corresponding conditions to those already noted in pig-iron are also observable in the market for scrap material, business all round remaining flat in the extreme. In Lancashire the foundry scrap market is depressed by the further weakness in pig-iron. Foundrymen were for a long time able to buy good scrap at about 10s. to 15s. per ton below the price of common No. 3 pig-iron, and hence they think 75s. should now be the price of the material. Dealers are not prepared to accept less than 80s., and so the trade hangs fire for the moment. In Scotland first-quality machinery cast-iron scrap is still around 85s. per ton, and for second quality to the same specification 80s. per ton. Cast-iron railway chairs are 83s. 6d. to 85s. per ton, light cast-iron around 72s. 6d. per ton, and if mixed with firebars 2s. 6d. per ton less. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—Movements in standard copper at the moment are practically featureless, and though a certain volume of everyday business is passing, the market is generally sluggish from a speculative viewpoint. In the conditions now current, prices have naturally eased, but the weakness has been accompanied by liberal offers of electrolytic at considerable concessions, which have attracted some substantial purchases. Current quotations:—*Cash*: Thursday, £62 10s.; Friday, £63; Monday, £62 10s.; Tuesday, £62 7s. 6d.; Wednesday, £62 5s.

Three Months: Thursday, £63 12s. 6d.; Friday, £64 2s. 6d.; Monday, £63 10s.; Tuesday, £63 10s.; Wednesday, £63 5s.

Tin.—Values of this metal continue on the down grade, a depreciation of £30 per ton since the corresponding date last year marking the extent of the collapse, although the outlook may be regarded as more hopeful owing to sustained buying of three months and firmer Eastern advices. The returns, albeit rather disappointing, were not unsatisfactory. The American deliveries, as a matter of fact, were quite good at over 7,200 tons, but, on the other hand, the outgoings in the U.K. and on the Continent were somewhat poor, while the Straits shipments were fully up to expectations, amounting for February to 7,350 tons for European ports, and in addition to this some 400 tons were despatched to Far Eastern ports

Current quotations:—*Cash*: Thursday, £242 15s.; Friday, £247 10s.; Monday, £245 15s.; Tuesday, £245; Wednesday, £246.

Three Months: Thursday, £246 5s.; Friday, £251; Monday, £249 10s.; Tuesday, £248 5s.; Wednesday, £249 5s.

Spelter.—The market for this metal reveals no fresh feature, as the demand from home consumers is still slow, and the quietude which has recently descended on the Continent shows no indication of lifting. In spite of several spells of rather heavy liquidation, the market here held up well, the relatively low price of the metal precluding any serious decline. On the other hand, no sustained upward movement in values can be expected for the time being. Current quotations:—*Ordinary*: Thursday, £35 5s.; Friday, £35 15s.; Monday, £35 17s. 6d.; Tuesday, £35 15s.; Wednesday, £36.

Lead.—The position of soft foreign pig remains unsettled, German and French interest having abated, while it is also reported that Japanese consumption has fallen off considerably. There is not much animation noticeable, and the position is largely artificial. Supplies seem to be enlarging a little, and are certainly more liquid. Current quotations:—*Soft foreign (prompt)*: Thursday, £36 12s. 6d.; Friday, £37 7s. 6d.; Monday, £36 17s. 6d.; Tuesday, £36 12s. 6d.; Wednesday, £36 5s.

South Wales Institute of Engineers.—The detailed programme of the Summer Meeting of this Institute has been issued. The meeting will take the form of a trip to Holland, extending from June 20 to June 30, and comprising visits to the Hague, to Scheveningen (where the headquarters of the Institute will be established at the Kurhaus), to Rotterdam, Isle of Marken, Amsterdam, Utrecht, Haarlemermeer Polder, and Noordwijk. Visits to works and to collieries in Limburg are also being arranged. An extension of the meeting in the shape of a visit to Luxemburg is also in contemplation.

Testing Refractories by Painting.—Dr. Eduard Steinhoff and Dr. Fritz Hartmann, in a recent issue of "Stahl und Eisen," describe a comparatively simple method of testing the structure of refractory materials by painting the polished surfaces of them with organic dyes after previous etching. By this method it was found possible, we are told, (1) to obtain an idea of the temperature at which the clay was burnt and a clue as to the admixture of objectionable impurities; (2) the temperature at which firebricks were burnt, the occurrence and distribution of quartz, and local fusions of material of high lime and magnesia content; also the degree of transformation of the lean material mixed with the quartz; (3) the presence and bedding of thin layers of kaolin in quartzites and the progress and manner of the quartz transformation; (4) the phase of quartz transformation in the case of silica bricks, and the behaviour of silicate fusions. The method has been used for some time in the laboratory of the Dortmund Union of the German Ironmasters' Association.